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Site Specific Monitoring Plan
for a
Sewage Sludge Incinerator

City of Warren
Wastewater Treatment Plant

July 2021 Update

Prepared for:

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Site Specific Monitoring Plan

For a Sewage Sludge Incinerator

At the

City of Warren, Michigan
Wastewater Treatment Plant

JULY 1, 2021
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(Finalized 9/15/21)

PRESENTED TO

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REPORT CERTIFICATION

The material and data in this document were prepared under the supervision and direction of the undersigned.

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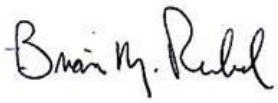

Brian Rubel, P.E. — 9/15/2021
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ACRONYMS, ABBREVIATIONS, AND LETTER SYMBOLS

Acronyms/Abbreviations	Definition
AQD	Air Quality Division
EGLE	Michigan Department of Energy, Great Lakes, and Environment
MAERS	Michigan Air Emissions Reporting System
CFR	code of federal regulations
EPA	United States Environmental Protection Agency
HAP	hazardous air pollutant
HHV	higher heating value
LHV	lower heating value
MW	molecular weight
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emission Standards for Hazardous Air Pollutants
NSPS	New Source Performance Standards
PSD	Prevention of Significant Deterioration
ROP	Renewable operating permit (Title V operating permit)
SCADA	Supervisory control and data acquisition
SSI	Sewage sludge incinerator
WWTP	Wastewater treatment plant
STP	Standard temperature and pressure
°C	degrees Celsius
acfm	actual cubic feet per minute
atm	atmosphere
atm-ft^3/lb-mol-R	atmosphere cubic foot per pound mole Rankine
Btu	British thermal unit
cal/s	calorie per second
CO	carbon monoxide
dscfm	dry standard cubic foot, feet per minute
ft	foot, feet
ft/min	foot per minute
ft/s	foot per second
ft^3	cubic foot
gpm	gallon per minute
g	gram
g/dscm	grams per dry standard cubic meter
hr	hour
in	inch
ºK	Kelvin (temperature)

lb/hr	pound(s) per hour
m	meter
m/s	meter(s) per second
m^3	cubic meter(s)
mg	milligram
Mg	megagram (metric ton)
mi	mile(s)
min	minute (s)
mm	millimeter
MM	million
mol	mole
MT	metric ton (megagram)
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
Pb	lead
PM	particulate matter (TSP)
PM_{10}	particulate matter ≤ 10 microns
$PM_{2.5}$	particulate matter ≤ 2.5 microns
ppbv	parts per billion by volume
ppbw	parts per billion by weight
ppmv	parts per million by volume
ppmw	parts per million by weight
ºR	Rankine (temperature)
R	universal gas constant
scf	standard cubic foot
scfm	standard cubic feet per minute
sec	second
SO_2	sulfur dioxide
tpd, ton/day	ton(s) per day
tph, ton/hr	ton(s) per hour
tpy, TPY	ton(s) per year
TSP	total suspended particulate (PM)
µg	microgram
µg/dsl	microgram per dry standard liter
$\mu g/m^3$	microgram per cubic meter
VOC	volatile organic compound
yd^3	cubic yards

1.0 INTRODUCTION

1.1 SITE SPECIFIC MONITORING PLAN OVERVIEW

The City of Warren, Michigan currently operates a Wastewater Treatment Plant Sewage Sludge Incinerator that combusts waste sludge generated in the water treatment process, the residual of which can then be disposed of as ash. The incinerator is subject to multiple air emission regulations, one of which is the Standards of Performance for New Stationary Sources (or New Source Performance Standard; abbreviated "NSPS") Subpart MMMM – Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units (hereafter NSPS Subpart MMMM). This federal regulation is found at 40 CFR §60.5000 through §60.5250. Under NSPS Subpart MMMM, the Warren WWTP incinerator is considered an "existing" unit because it is a Multiple Hearth sewage sludge incinerator (SSI) that was constructed before October 14, 2010.

This Site Specific Monitoring Plan (SSMP) was initially developed in May 2016 in advance of the initial performance test conducted on the incinerator in June 2016. Since that time, the facility has operated in compliance with the requirements of the initial SSMP, however periodic update of the Plan is necessary. Performance testing is utilized not only to determine compliance with the emission limitations imposed on the multiple hearth SSI, but also to establish site specific "operating parameters" for the process and control equipment that relate to air pollution control. These operational parameters are monitored on a continuous basis and can be used to determine ongoing compliance with the NSPS Subpart MMMM requirements.

The Warren WWTP facility is located at 32360 Warkop Ave, Warren, Oakland County, Michigan 48093 and is assigned State Registration Number (SRN) B1792. The existing facility is designed and operated to process wastewater from the city of Warren, Michigan and has been in operation since the 1950's. The Warren WWTP currently operates under Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD) Renewable Operating Permit No. MI-ROP-B1792-2016.

As water is cleaned throughout the water treatment plant, solids are collected and routed to the incinerator to reduce the watery solids to ash with much less volume, which can ultimately be disposed of in a final destination off-site.

The incineration process is controlled by regulating the combustion temperature within the incinerator to a high enough level that it can completely combust the sludge feed into ash and eliminate the water in the feed. The combustion temperature must be maintained at a facility-specific minimum temperature that is established during the most recent compliant stack testing on the incinerator. For continuous compliance with the emission limitations that are demonstrated though stack testing, the facility is required to install and

maintain incinerator temperature monitoring devices on a continuous basis and collect and maintain the data that shows that they continuously operate the incinerator at or above the required minimum temperature.

In addition to monitoring the parameter for temperature in the combustion zone of the incinerator, the facility is also required to monitor certain parameters on the water scrubber that handles the exhaust gas effluent from the incinerator. The scrubber is used to reduce the particulate and other pollutants (i.e. metals, acids, gases, etc) prior to the exhaust of the outlet gases to atmosphere. There are three parameters that require installation of monitoring equipment on the scrubber to continuously track. These parameters are scrubber water flow rate, scrubber water acidity (pH), and pressure drop across the scrubber.

The scrubber uses water flowing in a direction that is countercurrent to the exhaust gases that enter from the incinerator and the water flow rate must be maintained at a minimum level that is established during the most recent compliant stack testing. For continuous compliance with the emission limitations that are demonstrated though stack testing, the facility is required to install and maintain scrubber water flow rate monitoring devices which continuously collect and record data showing that the flow rate is continuously kept at or above the required minimum rate.

The scrubber water acidity level (pH) provides an indication of how much fresh water needs to be added in order for the scrubber to neutralize acidic compounds in the incinerator exhaust. As the scrubber water absorbs compounds in the exhaust gases that enter from the incinerator, the pH can be altered and therefore the water pH must be maintained at a minimum level that is established during the most recent compliant stack testing. A pH of 7 is considered neutral, while a pH between 1-7 is considered acidic and between 7-14 is considered basic. For continuous compliance with the emission limitations that are demonstrated though stack testing, the facility is required to install and maintain a scrubber water pH monitoring device which continuously collects and provides records indicating that the scrubber water pH is continuously kept at or above the required minimum rate. It is important to note however, that the Warren WWTP scrubber does not recirculate any feed water within the scrubber and all water fed to the scrubber is considered “once through”, so that the same amount of water entering the scrubber also exits the scrubber.

Finally, the pressure drop across the scrubber must be monitored as an indication of whether the incinerator exhaust is properly contacting the liquid and if sufficient liquid flow is being utilized to achieve required control efficiency. Pressure drop is determined by taking pressure readings at the inlet of the incinerator exhaust to the scrubber (near the quench section) and at the outlet of exhaust from the scrubber (after the mist eliminator) and determining the difference. The pressure drop through the scrubber must be maintained at a minimum level that is established during the most recent compliant stack testing. For continuous compliance with the emission limitations that are demonstrated though stack testing, the facility is required to install and maintain a pressure monitoring devices which continuously collect and provide records indicating that the scrubber differential pressure is continuously kept at or above the required minimum value.

Section 2.0 through Section 7.0 provide the details of the SSMP for the Warren WWTP incinerator and emissions control, and how the facility is meeting the requirements of 40 CFR §60.5200.

Section 8.0 provides the Ash Handling System monitoring plan, which discusses the how the ash is designed to handle ash at the Warren WWTP in order to eliminate fugitive particulate emissions.

A diagram of the currently installed incinerator, along with PID drawings of the wet scrubber control device are provided in Appendix A. In addition, screen captures of associated operating data and operations HMI screens are provided in Appendix A. Monitoring equipment specifications and manufacturer information are provided in Appendix B. Information related to operation and maintenance of equipment is provided in Appendix C. Appendix D presents several examples of recent calibrations that have been performed on the various pieces of monitoring equipment. Appendix E provides a summary of the most recent operating parameter limitations, which were updated based on the operational data collected during the June 2020 emission compliance testing on the incinerator. For reference, NSPS Subpart MMMM is provided as Appendix F.

2.0 PLAN STRUCTURE

2.1 PLAN CONTENTS & STRUCTURE

This section provides an overview of the Site-Specific Monitoring Plan (SSMP). Essentially, the SSMP is broken into various sections that relate to the requirements for the plan as described in 40 CFR §60.5200(a) and (d).

Section 3.0 describes the monitoring equipment in detail and how the various devices are used to meet the requirements of 40 CFR §60.5200(a)(3), including where the equipment is installed, the performance and equipment specifications and the performance evaluation and acceptance criteria of each required piece of monitoring equipment.

Section 4.0 provides a discussion of the ongoing operation and maintenance procedures. Section 5.0 discusses the ongoing data quality assurance requirements along with provisions for periods when the continuous monitoring system is out of control. Section 6.0 discusses ongoing recordkeeping and reporting procedures, while Section 7.0 provides a discussion of the schedule for periodic performance evaluations of the CMS equipment.

Section 8.0 provides the Ash Handling System monitoring plan for preventing fugitive particulate emissions from the incinerator and scrubber ash handling operations.

Supporting documentation and other valuable information regarding the facility equipment utilized for monitoring operating parameters are provided in the various appendices.

3.0 EQUIPMENT SPECIFICATIONS

3.1 CONTINUOUS PARAMETER MONITORING EQUIPMENT

In order to determine compliance with the emission limits established for Multiple Hearth incinerators under the federal NSPS Subpart MMMM, the Warren WWTP facility currently is using the method of performing periodic stack (performance) testing and establishing values of parameters that are indicators of compliance during the stack testing and then continuously monitoring those parameters to demonstrate ongoing compliance.

As such, there must be reliable and accurate monitoring equipment installed and maintained to allow the required parameters to be monitored. The parameters that are required under 40 CFR §60.5190 to be monitored for the process and control of the incinerator at the Warren WWTP are as follows:

Table 3-1. Operating Limits Requiring Continuous Monitoring [1]

Parameter	Process/Control Equipment Monitored	Monitoring Device	Associated Pollutants
Temperature	Incinerator Hearth	Thermocouples	All pollutants
Differential Pressure	Scrubber	Pressure Transmitter	PM, Pb, Cd
Water Flow Rate	Scrubber	Electromagnetic Flow Measurement System	All pollutants
Effluent pH	Scrubber	pH Probe	SO_2, HCl

In accordance with 40 CFR §60.5200, the Warren WWTP facility SSMP has been developed to meet the requirements for each of the monitoring devices as detailed in the following subsections.

Most of the information detected by these devices is routed through various software and hardware elements to the facility's Supervisory Control and Data Acquisition (SCADA) system and also to the environmental continuous monitoring system data collecting software/computer developed by Trace Environmental Systems. The SCADA system allows the information gathered by detection devices/sensors to be processed, distributed, and displayed so that operators and supervisors can monitor, record, and analyze data necessary for operational and environmental purposes.

3.2 OPERATING TEMPERATURE MEASURING DEVICES

For the incinerator operating temperature measuring devices utilized to continuously monitor temperatures in the incinerator combustion zone, which is comprised of Hearth Nos. 4, 5 and 6, the following section details the requirements that must be met and how the Warren WWTP monitoring system is designed to meet those requirements:

§60.5200 (a)(1): ***Installation of the continuous monitoring sample probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions***

Thermocouples with temperature transmitters are installed in the Warren WWTP incinerator Hearth Nos. 4, 5 and 6 of the existing multiple hearth furnace to continuously monitor the combustion zone temperatures while the process is operating. Proper combustion temperature is necessary to reduce the sewage sludge to ash for subsequent disposal.

§60.5200 (a)(2): ***Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems***

JMS thermocouples with JMS 8H Isolated programmable temperature transmitters measuring in the range of 32 to 2300°F are installed to measure temperatures. In addition, Laurel Electronics QLS retransmitters are utilized for splitting output signals to multiple data systems. Data is continuously collected, reduced and saved on a 1-minute basis on the facility SCADA data acquisition system (DAS) and is also transmitted to the Trace Environmental Systems (QUAD M Compliance) data monitoring system.

Manufacturer information on these devices is provided in Appendix B.

§60.5200 (a)(3): Performance evaluation procedures and acceptance criteria (e.g. calibrations), which for a Continuous Parameter Monitoring System (CPMS), must include the following:

§60.5200 (a)(3)(ii)(D) ***if you have an operating limit that requires the use of a temperature measuring device, you must meet the requirements in (a)(3)(ii)(D)(1) through (4):***

(1) Install the temperature sensor and other necessary equipment in a position that provides a representative temperature

The thermocouples are installed at each of the hearths in a position that provides a representative temperature within the incinerator. The table below provides the Warren WWTP equipment ID's associated with these thermocouples.

Hearth Location	Warren WWTP Equipment ID#
Hearth #4	#08-07-16
Hearth #5	#08-07-14
Hearth #6	#08-07-13

(2) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 1.0-percent of the temperature value, whichever is larger, for a noncryogenic temperature range.

The JMS temperature sensors and 8H transmitters have an accuracy of 0.08°C or 0.08 percent of span. Maximum drift over 5 years is a maximum of 0.1°C or 0.1% of span. The temperatures of the incinerator hearths range from approximately 800°F to 1650°F during operation.

(3) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 2.5-percent of the temperature value, whichever is larger, for a cryogenic temperature range

Not applicable; temperature is non-cryogenic (see tolerance under (2), above)

(4) Conduct a temperature measurement device performance evaluation at the time of each performance test but no less frequently than annually

Thermocouples outputs are verified annually by WWTP calibration personnel and are verified just prior to any performance testing. Information related to calibrations are provided in Appendix D.

3.3 SCRUBBER FLOW MONITORING SYSTEM

For the flow monitoring system utilized on the wet scrubber to continuously monitor the flow of water into the scrubber, the following details the requirements that must be met and how the Warren WWTP monitoring system is designed to meet those requirements:

§60.5200 (a)(1): ***Installation of the continuous monitoring sample probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions***

Endress+Hauser model Proline Promag 50 Electromagnetic Flow Measuring devices are installed to measure water flow at every location in which water is fed into the VenturiPak Scrubber System. The inlet rates for all locations are measured remotely by sensors that provide signals to dedicated transmitters, which are then summed to provide a total inlet flow rate across the entire scrubber. The PLCs totalize the water flow and produce an analog output to the facility SCADA system. Individual flow meter readings are displayed on the SCADA HMI screens along with total flow. Total flow is output to the Trace Environmental Systems monitoring system where it is recorded on a minute-by-minute basis to produce one-hour averages.

§60.5200 (a)(2): ***Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems***

The Endress+Hauser electromagnetic flow measuring systems measure flow rates in water and wastewater applications up to 484315 gpm, but typically between 0 and 1000 gallons per minute by measuring the flow velocity within the pipes in which they are installed. Data is continuously collected, reduced and saved on a 1-minute basis on the facility SCADA data acquisition system (DAS) and the totalized value is also transmitted to the Trace Environmental Systems (QUAD M Compliance) data monitoring system.

Manufacturer information is provided in Appendix B.

§60.5200 (a)(3): Performance evaluation procedures and acceptance criteria (e.g. calibrations), which for a Continuous Parameter Monitoring System (CPMS), must include the following:

§60.5200 (a)(3)(ii)(A) ***if you have an operating limit that requires the use of a flow measuring system, you must meet the requirements in (a)(3)(ii)(A)(1) through (4):***

(1) Install the flow sensor and other necessary equipment in a position that provides a representative flow

To obtain representative flow, five (5) individual flow meters are installed at each branch of inlet water to the scrubber. These include: Quench inlet section to the scrubber, the condenser impingement trays, the Venturi tube inlet lances, the Venturi throat spray manifold, and the mist eliminator lances.

The monitoring devices were professionally installed during commissioning of the scrubber control device and provide accurate data on a continuous basis. The table below provides the Warren WWTP equipment ID's associated with these devices.

Flow Sensor Location	Warren WWTP Flow Sensor Equipment ID	Warren WWTP Flow Transmitter Equipment ID#
Quench	#08-07-41	FIT - 613
Condenser Impingement Trays	#08-07-44	FIT - 654
Venturi Inlet Sprays	#08-07-53	FIT - 660
Venturi Throat Sprays	#08-07-52	FIT - 707
Mist Eliminator	#08-07-55	FIT - 713

(2) Use a flow sensor with a measurement sensitivity of no greater than 2 percent of the expected process flow rate.

Sensitivity/accuracy of the flow sensors are +/- 0.5% of readings, as certified by the manufacturer

(3) Minimize the effects of swirling flow or abnormal velocity distributions due to upstream or downstream disturbances

All flow meters are installed to provide at least 10 diameters upstream and 5 downstream of any flow disturbances, if possible; and at a minimum provide 5 diameters upstream and 3 diameters downstream of each meter

(4) Conduct a flow monitoring system performance evaluation in accordance with your monitoring plan at the time of each performance test but no less frequently than annually

The flow sensors are calibrated annually in accordance with the manufacturer specification by a Warren WWTP calibration contractor or other qualified person and just prior to any performance testing.

3.4 SCRUBBER PRESSURE MONITORING SYSTEM

For the pressure monitoring system utilized on the wet scrubber to continuously monitor the pressure drop across the scrubber, the following provides details of the requirements that must be met and how the Warren WWTP monitoring system is designed to meet those requirements:

§60.5200 (a)(1): ***Installation of the continuous monitoring sample probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions***

An Endress+Hauser model Deltabar S differential pressure measuring transmitter is installed on the wet scrubber system to measure differential pressure across the entire scrubber. The "differential" is set up to determine the difference between the inlet of the scrubber quench zone and the outlet of exhaust at the exit of the scrubber. If the differential pressure goes below a minimum threshold, this would indicate that the exhaust gas from the incinerator that is being treated in the scrubber is passing through the control device too quickly, which would need to be addressed.

§60.5200 (a)(2): ***Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems***

The Endress+Hauser Deltabar S model PMD75 process pressure measuring system, measures the differential pressure in liquid and wastewater applications up to 40 bar (16,058 inches H_2O); typical pressures will be between 0 and 50 inches of water column (inches H_2O). Data is continuously collected, reduced and saved on a 1-minute basis on the facility SCADA data acquisition system (DAS) and values are also transmitted to the Trace Environmental Systems (QUAD M Compliance) data monitoring system.

Manufacturer information is provided in Appendix B.

§60.5200 (a)(3): Performance evaluation procedures and acceptance criteria (e.g. calibrations), which for a Continuous Parameter Monitoring System (CPMS), must include the following:

§60.5200 (a)(3)(ii)(B) ***if you have an operating limit that requires the use of a pressure monitoring system, you must meet the requirements in (a)(3)(ii)(B)(1) through (6):***

(1) Install the pressure sensor(s) in a position that provides a representative measurement of the pressure (e.g. particulate matter scrubber pressure drop).

The Deltabar S PMD75 differential pressure measuring device/transmitter is installed on the wet scrubber system to measure differential pressure across the entire scrubber. The differential is set up to determine the difference between the inlet of the scrubber quench zone and the outlet of exhaust at the exit of the scrubber.

Description	Warren WWTP Pressure Sensor Equipment ID	Warren WWTP Pressure Transmitter Equipment ID#
Differential Pressure Meter	#08-07-47	PDIT - 625

(2) Minimize or eliminate pulsating pressure, vibration, and internal and external corrosion.

The pressure sensor is located such that vibration and pulsating pressures are minimized and corrosion has not been encountered in this application. In addition, the Deltabar S is designed with vibration resistance. Corrosion has not been noted at any time that access to the internal parts of the meter has been available. The scrubber uses fresh water (i.e. once-through) and no corrosive additives are used.

(3) Use a pressure sensor with a minimum tolerance of 1.27 cm of water or a minimum tolerance of 1 percent of the pressure monitoring system operating range, whichever is less.

The Endress+Hauser Deltabar S model PMD75 gauge has a maximum permissible error of +/- 0.035%, as certified by the manufacturer.

(4) Perform checks at least once each process operating day to ensure pressure measurements are not obstructed (e.g. check for pressure tap pluggage daily)

Data is continuously evaluated by operators, and logged several times daily, when the process is in operation with sludge being incinerated. If pressure measurements deviate from normal differential pressure (i.e. fall below the allowable operating parameter limit), investigation as to the cause is initiated.

(5) Conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually

Calibrations are performed annually in accordance with manufacturer's specification by qualified WWTP calibration personnel. Annual calibrations are conducted just prior to any performance testing, when applicable. Pressure device outputs will be compared against atmospheric pressure and known input pressures with an acceptable air pressure meter. A device that falls out of tolerance will be sent back to the factory for recertification and a replacement gauge will be installed. An example of a calibration performed on the differential pressure measurement device is provided in Appendix D.

(6) If at any time the measured pressure exceeds the manufacturer's specified maximum operating pressure range, conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan and confirm that the pressure monitoring system continues to meet the performance requirements in your monitoring plan. Alternatively, install and verify the operation of a new pressure sensor.

The operating range of the Deltabar S pressure gauge is set for 0-50 inches WC. Should the pressure measured exceed this range, a performance evaluation will be conducted and a calibration will be done if necessary. The gauge will be assessed to ensure the correct range is being read. Should the gauge not read pressure correctly after calibration, a new gauge will be installed.

3.5 SCRUBBER ACIDITY (pH) MONITORING SYSTEM

For the pH monitoring system utilized on the wet scrubber to continuously monitor the acidity of the outlet scrubber water from the scrubber, the following provides details of the requirements that must be met and how the Warren WWTP monitoring system is designed to meet those requirements:

§60.5200 (a)(1): ***Installation of the continuous monitoring sample probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions***

An Endress+Hauser ISFET sensor pH measuring probe is installed on the drain line of the scrubber where water exits from the Venturi stage and is sent to the ash pumps. The water exiting the scrubber at this stage would contain any acidic compounds controlled by the water scrubber.

§60.5200 (a)(2): ***Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems***

The Endress+Hauser ISFET sensor pH measuring probe and transmitter provides pH measurements in these applications on the full scale of 0 – 14. The CPS491 probes (currently used) are made for application in high dirt conditions and has an accuracy of 0.2% of the measuring range. The sensor is housed in an Endress+Hauser Cleanfit CPA450 retractable assembly and data is transmitted via an Endress+Hauser Liquiline CM44x multichannel controller. Data is continuously collected, reduced and saved on a 1 minute basis on the facility SCADA data acquisition system (DAS) and values are also transmitted to the Trace (QUAD M Compliance) data monitoring system.

Manufacturer information of the pH equipment is provided in Appendix B.

§60.5200 (a)(3): Performance evaluation procedures and acceptance criteria (e.g. calibrations), which for a Continuous Parameter Monitoring System (CPMS), must include the following:

§60.5200 (a)(3)(ii)(C) ***if you have an operating limit that requires a pH monitoring system, you must meet the requirements in (a)(3)(ii)(C)(1) through (4):***

(1) Install the pH sensor in a position that provides representative measurement of scrubber effluent pH.

The pH probe is installed in the venturi drain which is a representative placement due to acid gas scrubbing that occurs after the Micro Mist Venturi and second Dual Orifice Impingement separator tray phases, which are the 4th and 5th stages in the scrubber.

Sensor	Warren WWTP pH Sensor Equipment ID	Warren WWTP pH Transmitter Equipment ID#
pH Probe	#08-07-43	AIT - 825

(2) Ensure the sample is properly mixed and representative of the fluid to be measured.

Samples are all representative samples as the probe is installed in a pipe of well-mixed effluent water that is continuously draining from the scrubber.

(3) Conduct a performance evaluation of the pH monitoring system in accordance with your monitoring plan at least once each process operating day

Each operating day the performance of the pH probe is evaluated by comparing the values to those of the previous day and to the operational limit. When the incinerator is operating with sewage sludge being incinerated, operators are continuously monitoring the pH of the scrubber effluent as a daily performance evaluation. Operators log the pH several times/day on the Multi-Hearth Furnace (MHF) log sheet, an example of which is included in Appendix C. Should pH be recognized through comparison with previous data as being out of range, the probe output will be verified by immersing the probe in a known pH buffer solution. If the probe is accurate, no further evaluation will be performed. If the probe is not accurate a full two-point calibration will be performed. If the calibration is unsuccessful, the probe will be replaced with a new probe.

(4) Conduct a performance evaluation (including a two-point calibration with one of the two buffer solutions having a pH within 1 of the operating limit pH level) of the pH monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than quarterly

A two-point calibration with one of the two buffer solutions will be conducted quarterly and at the time of annual performance testing. The buffer solutions will have a pH of 4 and 7, the latter of which is within 1 of the expected operating limit of 6.3 to 6.5.

An example calibration is included in Appendix D.

3.6 SCALE FOR MEASURING SLUDGE FEED

Although not required to be in the SSMP, the Warren WWTP in also including information in this document for the weighing scale that is used for determining, on a continuous basis, the sewage sludge feed rate to the incinerator. Daily feed rates are determined using the scale. During performance testing (i.e. stack testing for emissions), the scale is required to be used for determining the rate at which sludge is fed for each test run used for compliance demonstration purposes.

The Warren WWTP uses a Thermo Scientific Model 9101 MicroTech belt scale meter with Ramsey scale junction boxes on the feed conveyer(s) that continuously monitors and records the amount of sewage sludge that is fed to the incinerator. The meter tracks the belt speed and weight to determine tons per hour feed rates and then totalizes these to obtain the tons/hour and tons/day of sludge fed to the incinerator.

The feed rate information is output to the facility SCADA on a continuous basis and data is collected, reduced and saved on a 1 minute basis. Values of the feed rate are also transmitted to the Trace (QUAD M Compliance) data monitoring system.

The scales and MicroTech 9101 are calibrated on an annual basis, which are timed near any emission testing when applicable, so that the feed rates are accurate on a continuous basis.

Manufacturer information on the MicroTech 9101 is provided at the end of Appendix B and an example of the calibration is included in Appendix D.

Instrument	Warren WWTP Equipment ID#
Feed Scale	#07-10-25

4.0 OPERATION AND MAINTENANCE

In accordance with NSPS Subpart MMMM under 40 CFR §60.5200(a)(4), the facility must adhere to requirements for ongoing operation and maintenance procedures in accordance with the general NSPS requirements under 40 CFR §60.11(d), which states that:

> *"At all times, including periods of startup, shutdown, and malfunction, owners and operators shall, to the extent practicable, maintain and operate any affected facility including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Administrator which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source."*

For the SSMP, the items discussed in Section 3.0 must be inspected and maintained in order to provide the highest quality and the most continuous monitoring data possible. Operation of the actual pollution control equipment and emission source (i.e. the incinerator) are not within the scope of this SSMP. The items for which operation and maintenance information is provided in this SSMP are limited to the devices that provide the monitored data that is required under NSPS Subpart MMMM. However, the scrubber undergoes an annual inspection to ensure that it maintains proper operating capability and this inspection is submitted by Warren WWTP to the agency in the Subpart MMMM Annual Compliance Report.

Operation and maintenance of the SSMP equipment is essentially done by making sure that instruments are properly calibrated at the required frequency and that data is continuously collected, and that devices that no longer meet calibration requirements are replaced. Inspections and maintenance activities will vary depending on the piece of monitoring equipment. An example copy of the Multi-Hearth Furnace (MHF) log sheet that is maintained by operators on a daily basis is provided in Appendix C, and is used to help detect whether operating parameter values are in the proper range. In addition, Appendix C provides inspection checklists and some example work orders that have been conducted.

4.1 TEMPERATURE MEASURING DEVICES

To assure that temperature measuring devices are operating properly the Warren WWTP facility currently calibrates the thermocouples and temperature transmitting devices on an annual frequency. Data is continuously viewed by operators and since the proper operation of the incinerator is dependent upon meeting proper operating temperatures, any abnormalities in data would be easily detected.

Hearth temperatures transmitted by the thermocouples are logged several times per day on the Multi-Hearth Furnace (MHF) log sheet by the operators of the incinerator when the incinerator is actively processing

sludge. The thermocouples are inspected when/if any data abnormalities are observed and are cleaned or replaced as necessary.

If a temperature probe is found to be providing operating values that are considered out of range and/or values are not changing, an inspection of the device is initiated. The electrical department will inspect the probe to observe whether it is visibly damaged, and then replace if necessary. If visible damage is not detected, then a "manual, loop calibration" device is used to check for PLC card issues, transmitter issues, and/or wire failures. Once the source of issue is detected, the proper parts are replaced until the issue is fully resolved.

Photos showing the Hearth No. 4, 5, and 6 thermocouple assemblies are provided in Appendix D which show the placement of annual calibration stickers on the head section of each thermocouple.

4.2 LIQUID FLOW MEASURING DEVICES

To assure that the flow measuring devices are operating properly on the Warren WWTP facility scrubber, the facility currently calibrates the flow measurement and transmitting devices on an annual basis. Data for the total scrubber flow is continuously displayed on the operators' HMI screens and any abnormalities in data would be easily detected.

The flow measuring devices are inspected when/if any data abnormalities are observed. Operators log the scrubber flow several times on a daily basis in order to detect signs of unusual flow.

An annual inspection and preventative maintenance for the scrubber and monitoring devices are performed by qualified personnel.

If a flow measuring device is found to be providing operating values that are considered out of range and/or values are not changing, an inspection of the device is initiated. The electrical department will inspect the flow meter PLC card using a "manual, loop calibration" device. If the PLC is not the issue, then a factory authorized repair representative for the manufacturer will be contacted to come to the plant to determine the issue and replace or repair the device. Note that to date, this has never occurred.

4.3 DIFFERENTIAL PRESSURE MEASURING SYSTEM

To assure that the differential pressure measuring device is operating properly on the Warren WWTP facility scrubber, the facility currently calibrates the measurement and transmitting devices on an annual basis. Data for the scrubber differential pressure is continuously displayed on the operators' HMI screens and any abnormalities in data will be easily detected.

The scrubber differential pressure measuring system is inspected when/if any data abnormalities are observed. Trending data for the scrubber differential pressure and draft pressure are continuously monitored by operators when the incinerator is actively processing sludge. Operators log the differential pressure on their required operational log sheet (MHF Daily Log Sheet) several times daily.

An annual inspection and preventative maintenance for the scrubber and monitoring devices are performed by qualified personnel.

If the differential pressure measuring device is found to be providing operating values that are considered out of range and/or values are not changing, an inspection of the device is initiated. The electrical department will inspect the appropriate PLC card using a “manual, loop calibration” device. If the PLC is not the issue, then a factory authorized repair representative for the manufacturer will be contacted to come to the plant to determine the issue and replace or repair the device. Note that to date, this has never occurred.

4.4 ACIDITY (pH) MEASURING DEVICES

To assure that the pH measuring devices are operating properly the Warren WWTP facility currently calibrates the pH probe and transmitting device on a quarterly frequency. Data is displayed on the HMI screens continuously and can be viewed by operators and therefore, any abnormalities in data would be easily detected.

The pH devices are inspected when/if any data abnormalities are observed. Daily checks on the pH meter and probe are conducted by observing and recording readings on the operator MHF Daily Log Sheet. If any abnormal data (i.e. non-compliant with operating parameter limit) is observed, an investigation will be initiated to check on the probe accuracy and replace the pH probe, if necessary.

A spare pH probe is kept on hand at the facility, should the probe become faulty and need to be replaced by the Warren WWTP qualified maintenance personnel. An annual inspection and preventative maintenance for the scrubber and monitoring devices are performed by qualified personnel.

If the pH measuring device is found to be providing operating values that are considered out of range and/or values are not changing, an inspection of the device is initiated. The electrical department will inspect the probe to observe whether it is visibly damaged, and then replace if necessary. If visible damage is not detected, then a “manual” verification of the probe is conducted by pulling the probe and doing a 2-point reading with known buffer solutions. If probe readings are inaccurate, the probe is replaced. If the probe is accurate, the a “manual, loop calibration” device is used to check for PLC card issues, transmitter issues, and/or wire failures. Once the source of issue is detected, the proper parts are replaced until the issue is fully resolved.

5.0 DATA QUALITY ASSURANCE & PROVISIONS FOR DOWNTIME

In accordance with NSPS Subpart MMMM under 40 CFR §60.5200(a)(5), the facility must adhere to requirements for ongoing data quality assurance procedures in accordance with the general NSPS Subpart A requirements under 40 CFR §60.13.

Although most of the requirements in NSPS Subpart A at 40 CFR §60.13 apply to CEMS and COMS that collect continuous emissions and opacity data, there are a few items that may apply to the continuous parameter monitoring under this SSMP.

1) 40 CFR §60.13(h)(2): the Warren WWTP collects data via the SCADA and Trace Environmental System data acquisition system, which provide for proper data reduction to produce 1-hour average results for the given operating parameters required under NSPS Subpart MMMM. Data that is collected during periods when the incinerator is not in operation (i.e. no sludge feed in the incinerator) is not used to determine compliance with the operational limits. Any hour during which maintenance is being performed on the monitoring system while the process is operating, will be excluded from the determination of compliance but will be considered DAS downtime.

Additionally, in accordance with NSPS Subpart MMMM under 40 CFR §60.5200(a)(7), the facility must adhere to provisions for periods when the continuous monitoring system is “out of control”.

Since “daily calibration error checks” are not required for the parameter monitoring equipment included in this SSMP, there are rarely any times when the monitoring system is considered “out of control”. In the rare occurrence that the entire system becomes inoperable (i.e. due to a system failure or power interruption), steps are taken to immediately address this situation, up to and including a controlled shutdown of the incinerator process until the cause is determined and successful corrective action has been taken.

Any time the parameter monitoring system loses the ability to operate during the (unlikely) event that the incinerator is operating, the facility will be required to report the duration of this occurrence as a deviation and provide the cause and corrective action for failure to monitor and record the required parameters. Data may be available on the SCADA system if the SCADA system is operational when the Trace Environmental data acquisition system is not functioning properly for data collection and recording purposes.

6.0 RECORDKEEPING AND REPORTING

In accordance with NSPS Subpart MMMM under 40 CFR §60.5200(a)(6), the facility must adhere to requirements for ongoing recordkeeping and reporting procedures in accordance with the general NSPS Subpart A requirements under 40 CFR §60.7(b), (c), (c)(1), (c)(4), and (d) through (g).

Most of the requirements in NSPS Subpart A at 40 CFR §60.13 apply to CEMS and COMS that collect continuous emissions and opacity data. Since the emission limitation compliance demonstration for Warren WWTP is determined by use of periodic stack testing, there are only a couple items that apply to the continuous parameter monitoring under this SSMP.

1) 40 CFR §60.7(b): the Warren WWTP will maintain records of any malfunctions that occur in the operation of the incinerator and associated control devices, along with any malfunctions of the data collection system for the operating parameters and periods during which the continuous monitoring system or monitoring devices are inoperative.
2) 40 CFR §60.7(c): the Warren WWTP will report any periods of CMS downtime in the semi-annual deviation reports required by the facility Renewable Operating Permit (ROP) when/if the continuous monitoring system fails to collect operating data during such times as the incinerator is operational with sewage sludge inside the incinerator.
3) 40 CFR §60.7(f): the Warren WWTP will maintain all required records for five years at a minimum, for data collected in the Trace Environmental System data acquisition system, for all performance evaluations and calibrations of monitoring devices and the monitoring system, and any maintenance activities performed on the monitoring devices and system.

Records of the 1-hour average values recorded for the combustion chamber operating temperature, scrubber differential pressure, scrubber water flow rate and scrubber pH, will be kept for a period of 5 years, as required under Subpart MMMM at 40 CFR §60.5230(f)(3)(i). Records of the daily average values recorded for the feed rate and moisture content of the sewage sludge fed to the incinerator, as required under Subpart MMMM at 40 CFR §60.5230(f)(3)(ii), will also be kept for 5 years.

Additionally, Warren WWTP will submit an Annual Compliance Report, as required pursuant to Subpart MMMM at 40 CFR 60.5235(c). This report will provide additional detail on any monitoring system downtime during process operation, any out of control periods, and any system malfunctions.

ROP deviation reporting will be used to report the date, time, cause and corrective actions associated with any time that the facility deviates from the allowable operational limitations that are based on facility compliance testing.

7.0 SCHEDULE FOR PERFORMANCE EVALUATIONS

NSPS Subpart MMMM requires the facility to provide a schedule for conducting initial and periodic performance evaluations of the continuous monitoring system under 40 CFR §60.5200(a)(8).

The initial performance evaluations for the devices and continuous monitoring system utilized at the Warren WWTP were conducted prior to initial performance testing on the incinerator, which occurred in June of 2016. At that time, operational parameters were established for the first time and testing showed compliance with the emission limitations for all pollutants.

Since that time, periodic evaluations (i.e. calibrations) have been performed on the following equipment at the indicated frequencies:

Table 7-1. Performance Evaluation Schedule

Parameter	Monitoring Equipment	Type of Evaluation	Frequency of Performance Evaluation
Temperature	Thermocouples	Calibration	Annually
Differential Pressure	Pressure Transmitter	Calibration	Annually
Water Flow Rate	Electromagnetic Flow Measurement System	Calibration	Annually
Effluent pH	pH Probe	Operator Evaluation; Calibration	Daily Checks; Quarterly Calibrations

8.0 ASH HANDLING SYSTEM MONITORING PLAN

Although not required to be a part of the Site Specific Monitoring Plan, NSPS Subpart MMMM requires the facility to also provide a Monitoring Plan for the ash handling system to ensure that the fugitive emission limit specified in Subpart MMMM is met by the facility.

The primary purpose of the Warren WWTP incinerator is to reduce the quantity of biosolids which requires disposal, while achieving the lowest health and environmental hazard levels. Combustion processes produce inorganic substances leftover as a residue, typically referred to as ash. The organic parts of the sludge are burned into primarily carbon dioxide and water vapor, which are treated in various air pollution control devices before being emitted to the atmosphere. Ash has a very limited volume compared to the amount of raw, water-ladened sludge that is fed to the incinerator, and this ash can be safely landfilled.

Ash (i.e. particulate matter) is captured in the facility venturi scrubber system, which is presently installed to control emissions from the exhaust gases of the incinerator. Ash is removed from the scrubber by pumping it through a conveyer system as a slurry (ash and plant effluent water) to one of two ash lagoons located at the plant. The removal and conveyance of ash slurry from the incinerator, until discharge into a lagoon, is an entirely enclosed system.

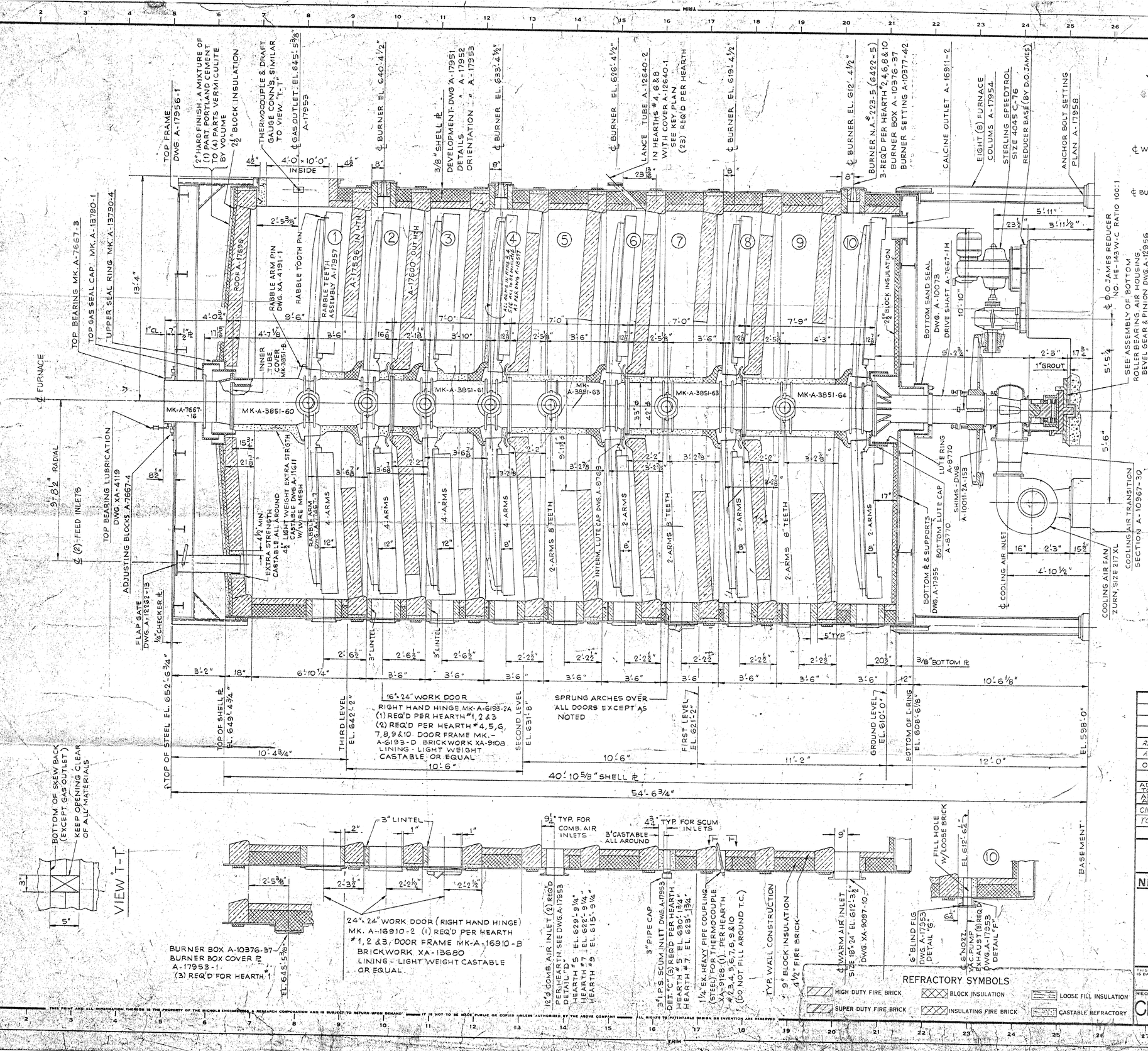
Each ash lagoon is 295 feet long, 38 feet wide at the top, 11 feet wide at the bottom, with a maximum working depth of 8 feet. The volume of each lagoon is approximately 53,900 cubic feet. By controlling either of two knife valves on the discharge line from the ash hopper, the ash slurry may be discharged into the head end of either lagoon. Both lagoons are filled from south to north to force the ash slurry toward the decant (north) end of each lagoon. Each ash lagoon is equipped with an outlet structure at the north end. Each outlet structure contains two manually operated plug valves that are used for decanting the lagoon at different levels. Overflow from the ash lagoons flows by gravity to the wastewater treatment plant's raw sewage wet well at the headworks of the wastewater treatment plant. One lagoon is in use while the second lagoon is being dewatered and emptied.

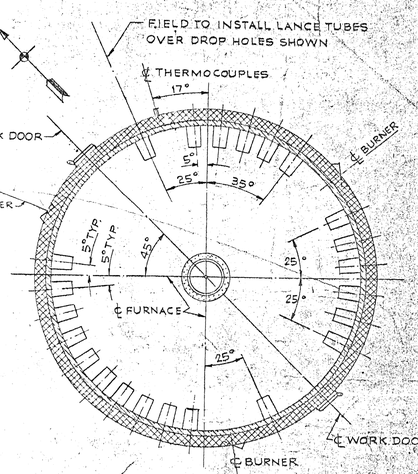
In accordance with Table 3 of NSPS Subpart MMMM, Warren WWTP is required to limit the fugitive emissions from the ash conveying systems such that visible emissions of combustion ash from the ash conveying system (including conveyor transfer points) occur for 5 percent or less of the hourly observation period for 3 one-hour observations, using U.S. EPA Method 22 to conduct the observations.

The Warren WWTP initially conducted three (3) one-hour observation periods for visible emissions utilizing Method 22 in March of 2016 at the operating ash lagoon and confirmed that the Warren WWTP ash handling system does not emit visible fugitive emissions based on its design characteristics. Warren WWTP has also conducted subsequent observations during particulate stack test performance evaluations at the facility in 2017 and 2020 and confirmed that there are no visible emissions. The facility will re-evaluate the ash handling system in the future if/when an operational change is made that may generate fugitive emissions.

APPENDIX A

Furnace Assembly, Scrubber PID Drawings,
And Operation Screen Captures





KEY PLAN

FOR FIELD LOCATION OF LANCE TUBES IN HEARTHS #4, 6 & 8

SCALE: 3/16" = 1 FT

REVISIONS	BY	CKD.	APP.	DATE	NO.
					6
					5
REMOVED BURNER EXTENSION TILES AND ADDED ARM INSULATION ON 4TH'S 3, 4, 5 & 6	M.V.	K.W.		FEB. 16, 72	4
OUTHEARTH WAS DRG. A-17599	T.T.	K.W.		SEP. 15, 71	3
ADDED (3) 6" NOZZLES WITH BLIND FLG TO HEARTH #10 VACUUM PUMP EXHAUST					
ADDED COOLING AIR FAN TRANSITION AND DRIVE FOR FURNACE SHAFT	T.T.	[illegible]		SEP. 9, 71	2
CHANGED DIMENSION FROM ℄ FURNACE TO ℄ FEED INLETS. ADDED CHECKER ℞.	C.L.C.	[illegible]		AUG. 6, 71	1

NICHOLS ENGINEERING & RESEARCH CORPORATION
NEW YORK, N.Y.

NICHOLS HERRESHOFF SLUDGE INCINERATOR
25'-9" O.D. - 10 HEARTH
CITY OF WARREN, MICH.
FURNACE ASSEMBLY

DOCUMENT ID - 53095

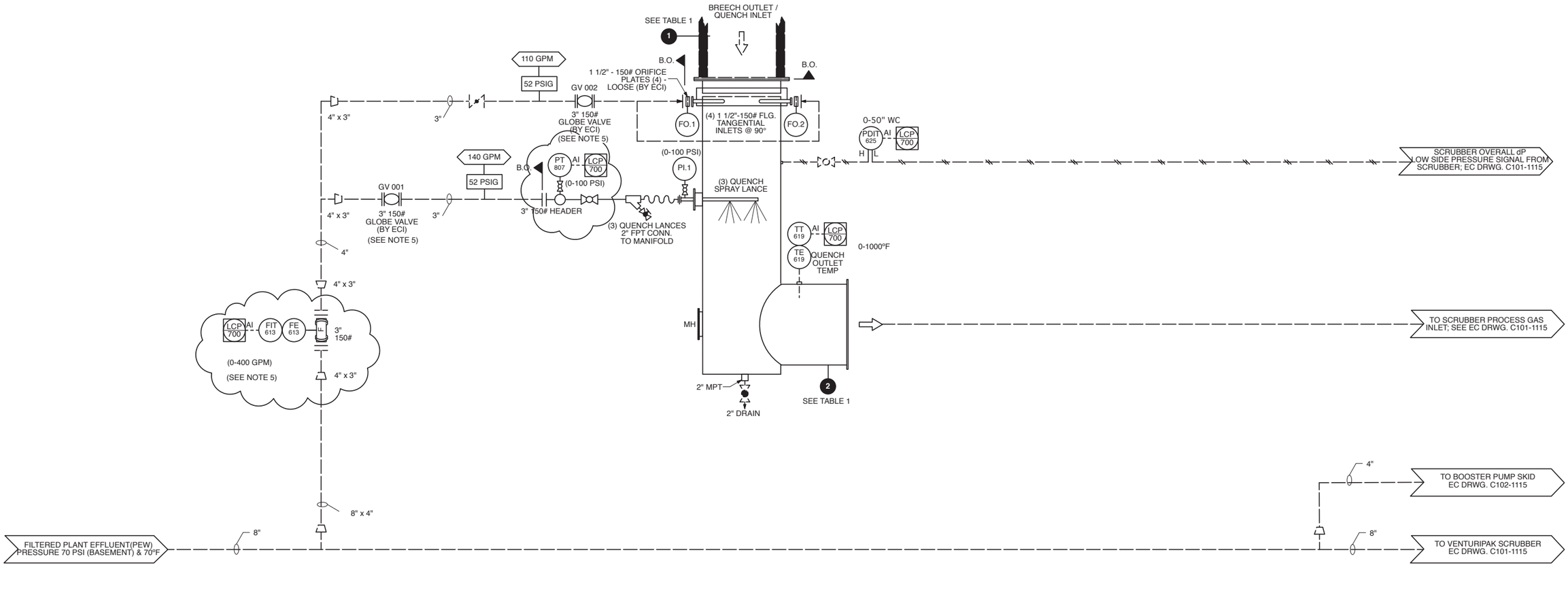
THIS DRAWING IS BASED ON
THIS DRAWING REPLACES
THIS DRAWING IS REPLACED BY

DRAWN: T.T. SCHMIDT JULY-20-71
TRACED
CHECKED: K.S. STEVENS JULY-20-71
APPROVED: [illegible]

REQUISITION: CE-1104-F
DATE: 7-27-71
SCALE: 3/8" = 1'-0" & AS NOTED
DRAWING: A-17950
ISSUE: 4

TABLE 1 - PROCESS DATA

POINT	MAX DESIGN
1. QUENCH INLET	
GAS VOL. (ACFM)	59,725
GAS TEMP (°F)	1,200
GAS PRESSURE ("WC)	-10
dP ACROSS QUENCH ("WC)	0.5
2. SCRUBBER INLET	
GAS VOL. (ACFM)	27,718
GAS TEMP (°F)	179
GAS PRESSURE ("WC)	-11
dP ACROSS TRAY STAGE ("WC)	8
dP ACROSS VENTURI STAGE ("WC)	20
dP ACROSS SEP/ME STAGE ("WC)	2
3. SCRUBBER OUTLET	
GAS VOL. (ACFM)	12,843
GAS TEMP (°F)	90
GAS PRESSURE ("WC)	-41



U.S. PATENT NO.: 6,719,829
U.S. PATENT NO.: 5,759,233
U.S. PATENT NO.: 5,279,646
OTHER U.S. PATENTS PENDING

NOTES:

1. ONE (1) SCRUBBER SYSTEM SUPPLIED BY ENVIROCARE AND INSTALLED BY OTHERS. OTHER THAN SPECIFIED EQUIPMENT BY ECI HEREIN, ALL CONTROLS EQUIPMENT, SOFTWARE, HARDWARE, AND INSTALLATION OF SUCH DEVICES IS PROVIDED BY OTHERS.
2. GASKETING & MOUNTING HARDWARE SUPPLIED BY OTHERS FOR ALL ECI TO "OTHERS" INTERFACE CONNECTIONS.
3. PUMP SIZING BASED ON AN AVERAGE INLET PRESSURE OF 70 PSIG AT ELEVATION 598 FT.
4. UTILITY WATER PRESSURES DICTATE FLOW AT EACH SCRUBBER INJECTION POINT. PRESSURES USED ARE THOSE SPECIFIED FROM THEIR RESPECTIVE WATER SUPPLIES AS SHOWN ON THIS DRAWING. INTERCONNECTING PIPING TO BE SIZED TO ACHIEVE NOTED PRESSURES AT EACH INJECTION POINT ELEVATION.
5. FIELD INSTRUMENTATION SUPPLIED BY ECI AND INSTALLED BY OTHERS.
6. ALL DRAIN TRAPS SHOULD BE AT APPROXIMATELY SAME LEVEL AS MAIN DRAIN.

SYM	REVISION DESCRIPTION	BY	APP	DATE
7	TAG UPDATE, AS BUILT	JTP	RAY	10.27.16
6	TAG UPDATE	MJP	RAY	1.25.16
5	CFC RESPONSE	MJP	RAY	11.13.15
4	CERTIFIED FOR CONSTRUCTION	MJP	RAY	10.29.15
3	ADJUSTED SCRUBBER OUTLET PRESSURE. ISSUED FOR CUSTOMER APPROVAL	GAC	RAY	7.17.15

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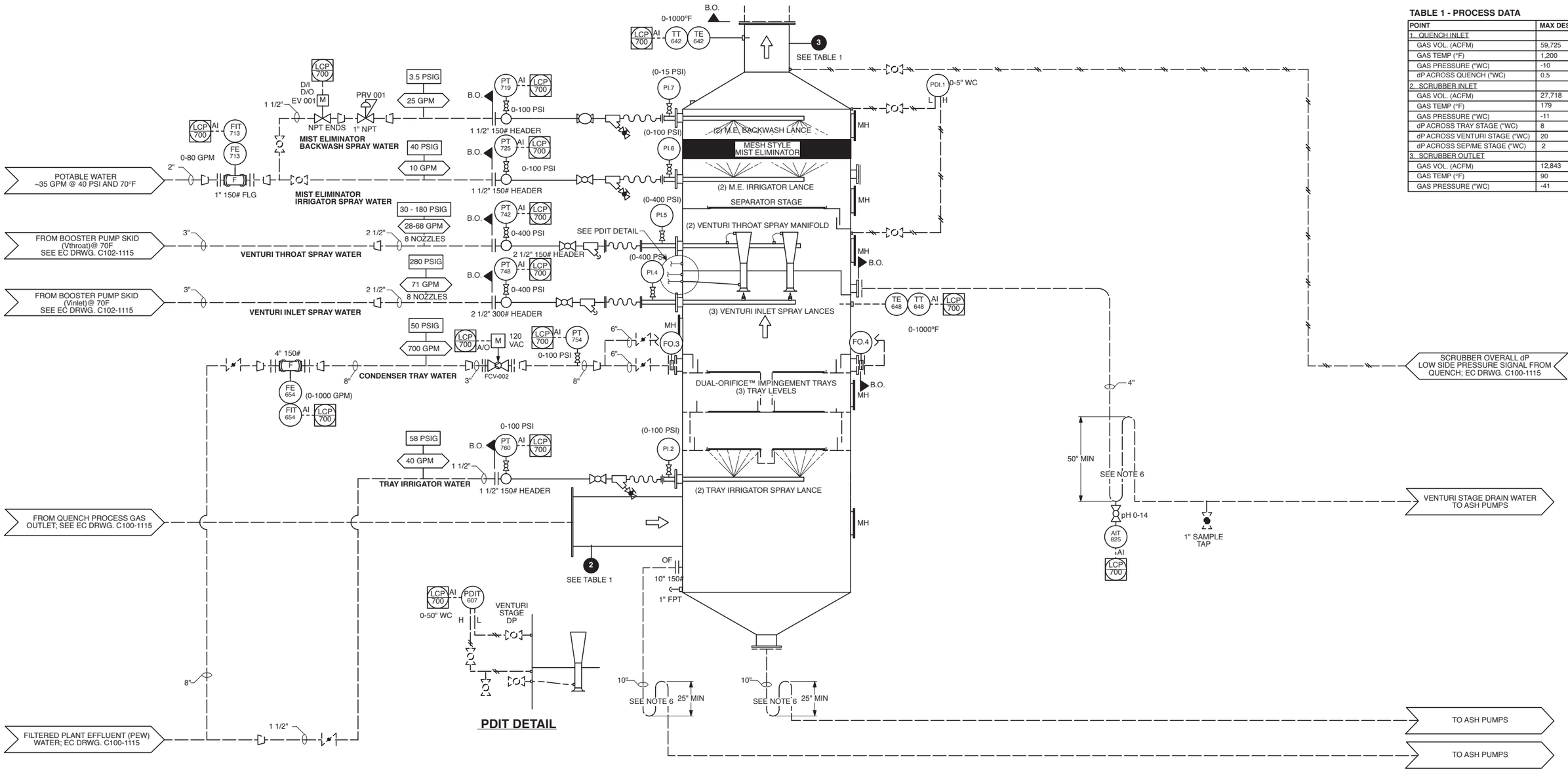
☐ Preliminary Issue ☐ Certified For Construction
☐ For Customer Approval ☐ As Built
BY _____ DATE _____

EnviroCare International
507 Green Island Road, American Canyon, CA 94503
Tel: 707/638.6800 Fax: 707/638.6898

TITLE: **PROCESS & INSTRUMENTATION DIAGRAM VENTURIPAK SCRUBBER QUENCH**

DRAWN	RAY	DATE	3.10.15
DESIGN	RAY	DATE	3.10.15
CHECK	MJP	DATE	3.16.15
APPR	JMT	DATE	3.16.15
SCALE	NONE		

CLIENT: **J.F. Cavanaugh**
PROJECT: WARREN WWTP WARREN, MI VENTURIPAK SCRUBBER
CONTRACT NO.: 1115
DRAWING NO.: C100-1115
ISO E
SHEET 1 OF 1
REV 7



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GAS PRESSURE ("WC)	-10
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GAS TEMP (°F)	90
GAS PRESSURE ("WC)	-41

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5. FIELD INSTRUMENTATION SUPPLIED AND INSTALLED BY OTHERS.
6. ALL DRAIN TRAPS SHOULD BE AT APPROXIMATELY SAME LEVEL AS MAIN DRAIN.

SYM	REVISION DESCRIPTION	BY	APP	DATE
7	TAG UPDATE, AS BUILT	JTP	RAY	10.27.16

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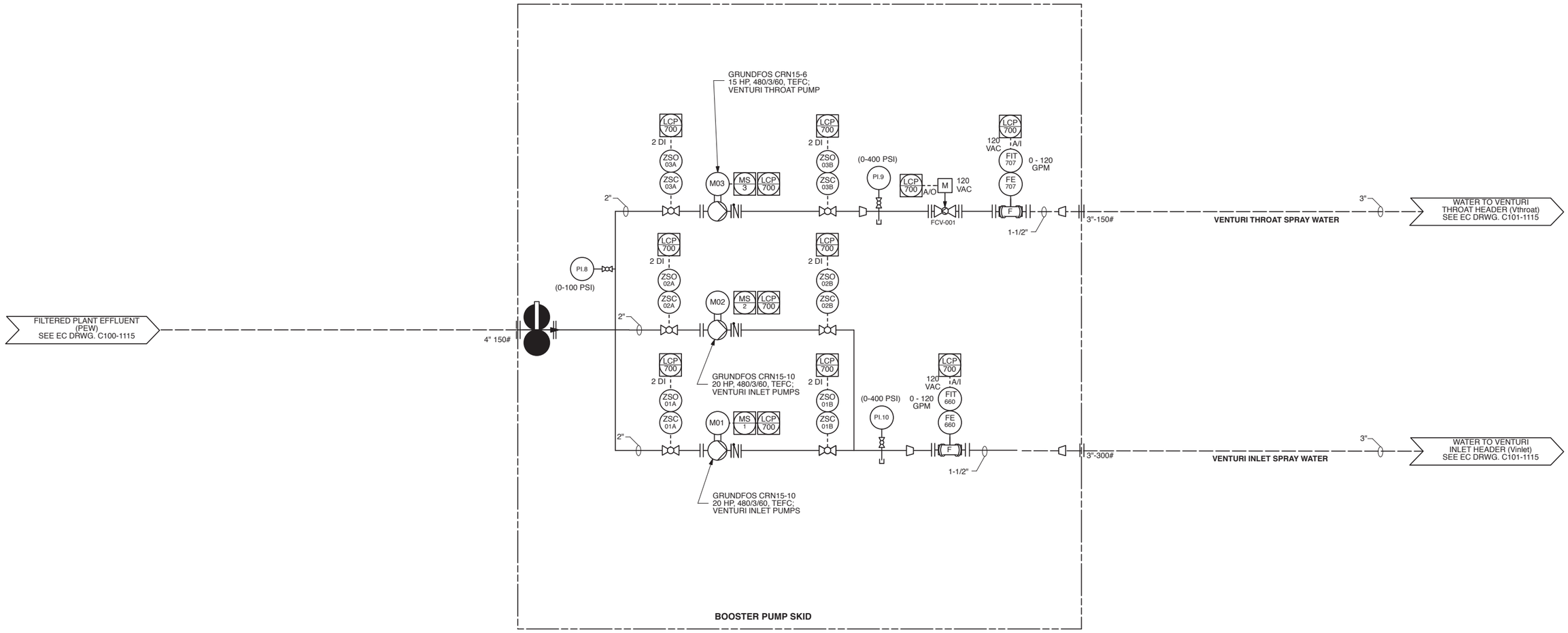
SYM	REVISION DESCRIPTION	BY	APP	DATE
6	TAG UPDATE	MJP	RAY	1.25.16
5	CFC RESPONSE	MJP	RAY	11.13.15
4	CERTIFIED FOR CONSTRUCTION	MJP	RAY	10.29.15
3	ADJUSTED FOR CUSTOMER COMMENTS. ISSUED FOR CUSTOMER APPROVAL	GAC	RAY	7.17.15

EnviroCare International
507 Green Island Road, American Canyon, CA 94503
Tel: 707/638.6800 Fax: 707/638.6898

TITLE: **PROCESS & INSTRUMENTATION DIAGRAM VENTURIPAK SCRUBBER**

DRAWN	RAY	DATE	3.10.15
DESIGN	RAY	DATE	3.10.15
CHECK	MJP	DATE	3.16.15
APPR	JMT	DATE	3.16.15
SCALE	NONE		

CLIENT: **J.F. Cavanaugh**
PROJECT: WARREN WWTP WARREN, MI VENTURIPAK SCRUBBER
CONTRACT NO.: 1115
ISO ⧉
DRAWING NO.: C101-1115
SHEET 1 OF 1
REV 7



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6. ALL DRAIN TRAPS SHOULD BE AT APPROXIMATELY SAME LEVEL AS MAIN DRAIN.

6	TAG UPDATE, AS BUILT	JTP	RAY	10.27.16

DOCUMENT RELEASE

☐ Preliminary Issue ☐ Certified For Construction
☐ For Customer Approval ☐ As Built

BY _____ DATE _____

5	CFC RESPONSE	MJP	RAY	11.24.15
4	CERTIFIED FOR CONSTRUCTION	MJP	RAY	10.29.15
3	ADDED THROAT WATER CONTROL VALVE. REMOVED VFD	GAC	RAY	7.6.15
2	ISSUED FOR CUSTOMER APPROVAL	GAC	JMT	6.26.15
SYM	REVISION DESCRIPTION	BY	APP	DATE

EnviroCare International
507 Green Island Road, American Canyon, CA 94503
Tel: 707/638.6800 Fax: 707/638.6898

TITLE
PROCESS & INSTRUMENTATION DIAGRAM VENTURIPAK SCRUBBER BOOSTER PUMPS

DRAWN	RAY	DATE	3.10.15
DESIGN	RAY	DATE	3.10.15
CHECK	MJP	DATE	3.16.15
APPR	JMT	DATE	3.16.15
SCALE	NONE		

CLIENT: J.F. Cavanaugh
PROJECT: WARREN WWTP WARREN, MI VENTURIPAK SCRUBBER
CONTRACT NO.: 1115
SIZE: D
DRAWING NO.: C102-1115
SHEET 1 OF 1
REV 5

Tuesday, June 15, 2021 9:42:29 AM

Stack
MD-5
D-5
D-4
O C S
D-7
D-6
10.5 % Dry O2
10.6 % Wet O2
59.2 T.H.C.
2093 SCFM
I.D. FAN
MD-3
Center Shaft Recycle Air
72 °F
-0.30 in WC
INCINERATOR DRAFT PRESSURE
24.7 in WC
SCRUBBER DIFFERENTIAL PRESSURE
QUENCHER
6.3 pH
Scrubber pH
DISCHARGE
OK
1462 °F
12 hr AVG
SECONDARY AIR
0 %
MD-2
0.00 in WC
210 CFM
CENTER SHAFT AIR TEMP
240 °F
25 %
5A 0 %
5B 1 %
7A 0 %
7B 0 %
9A 1 %
9B 0 %
Combustion Temp
1460 °F
0 %
0 %
49 %
100 %
0 %
5.1 Ton/Hr
Sludge Cake Feed Rate
48.290
Sludge Cake Totalized Feed Rate
Hearth Temperatures
868 °F 1
1038 °F 2
1038 °F 3
1438 °F 4
1466 °F 5
1474 °F 6
1439 °F 7
979 °F 8
303 °F 9
115 °F 10
0.2028 in WC
Incinerator Status
Purge Status
COMPLETE
Temp:
Not High
Pressure:
Not High
SGBT #1 Running 152.4 GPM
SGBT #2 Stopped -0.2 GPM
SGBT #3 Running 189.5 GPM
Sludge Tanks
31 in WC
2375 CFM
COMBUSTION AIR BLOWER
GAS
92 ACFM
388201
100 %
D-3
To Odor Control
20 %
D-1
0 CFM
Air Flow
689 RPM gear
7.6 % Torque
Center Shaft Drive
4.47 in WC
11960 CFM
Ash Pump #1
Ash Pump #2
69.6 PSIG
From NPW Pumps
Flush Valve
MAIN CS Cooling Fan
BACK UP

# of Alarms in System: 0034 Unacknowledged Alm: 0, Sup: 8

TIME	ALARM LABEL	DESCRIPTION	VALUE
8:56:19 AM	High	FE Turbidity	21.56
1:21:52 PM	Tot Hours Runtime	Booster Pump Alarm	1
6:25:02 AM	Cross Talon Alarm	Talon Alarm Status	1
8:00:56 AM	FE13 Flow West Line	Form Chloride Flow Meter	0.54
1:04:12 AM	Feed B	Feed Tank #8 Trouble	1
5:48:06 PM	WAS Vly not Auto	WAS to Blending Valve A/M	0
5:48:00 PM	WAS Vly not Auto	WAS Scum to Blending Valve A/M	0

Ack Current
Ack Page
Ack All

Scrubber
Incin Equipment Status
CEMS Status
Trend
Electrical Systems Monitoring
Screen List
Overview
Login
Alarm Horn Silence
Alarms
Front Gate
Realtime Trending

Clear
Clear All

WWTP Camera
Incinerator Top of...
HMI on WWTP3
HMI on WWTP3
9:42 AM 6/15/2021

City of Warren Wastewater Treatment Plant

SCRUBBER SYSTEM

Scrubber Skid

PUMPS

Venturi Inlet

Run	Mode	Status	Lead
Off	Auto	OK	No
On	Auto	OK	Yes

Venturi Throat

Run	Mode	Status	% Open
On	Auto	OK	12%OPEN

CV

PDIT 625
24.6 " WC
Scrubber DP

EV 001
Closed

FIT 713
7 GPM

PDIT 607
17 " WC

TT 648
74 F
64%OPEN

TT 619
146 F

QUENCHER

PT 807
39.7 PSI

FIT 613
388 GPM

MIST ELIMINATOR

CONDENSER TRAYS

SCRUBBER

TT 642
72 F

PT 719
0 PSI

PT 725
31 PSI

PT742
44 PSI

FIT 707
33 GPM

PT748
283 PSI

FIT 660
72 GPM

PT754
23 PSI

FIT 654
447 GPM

PT760
45 PSI

Total Scrubber Flow
949 GPM
LMT 806 GPM

Venturi Stage Drain
6.3 Ph
LMT 6.3 ph

TIME	ALARM LABEL	DESCRIPTION	VALUE
8:56:19 AM	High	FIT Turbidity	21.56
1:21:52 PM	Too Many Running	Booster Pump Alarm	1
9:25:02 AM	Crazy Fake Alarm	Fake Alarm Status	1
8:00:36 AM	FeCl3 Flow Wrot LOW	Ferric Chloride Flow Wrot	0.04
1:04:32 AM	Final 8	Final Tank #8 Trouble	1
5:48:06 PM	WAS Vlv not Auto	WAS to Blending Valve A/M	0
5:48:00 PM	WAS Vlv not Auto	WAS Scum to Blending Valve A/M	0

Ack Current
Ack Page
Identify
Sort

Scrubber Trend
Screen List
Overview
Incin Screen
Alarms
Front Gate
Realtime Trending

Clear
Clear All

WWTP Camera
Incinerator Top of...
HMI on WWTP3
HMI on WWTP3
9:44 AM
6/15/2021

Data Monitor - City of Warren - [QUAD M]

File Log ON Log OFF Data Displays Custom Screens Polling Data Processing/Re-Polling Ports Operator Terminal CPL Alarms/Events Analyzers Tools Help

City of Warren

QUAD M Compliance Data

		1 Min Avg	1 Hr Avg	3 Hr Avg	12 Hr Avg
O2 wet	[%]	9.7	9.3	9.9	10.4
O2 dry	[%]	9.3	9.0	9.7	9.3
THC wet	[ppm]	23.9	27.4	30.5	49.0
THC dry	[ppm]	23.9	27.4	30.5	49.0
THC dry @ 7%	[ppm]	28.6	31.9	37.4	57.5
Chamber	[Deg F]	1368	1388	1378	1360
Scrubber dP	["WC]	24.0	24.2	24.8	25.0
Scrubber pH	[pH]	6.4	6.4	6.3	6.4
Scrubber Flow	[GPM]	864.0	863.6	849.7	844.7

Compliance Watch

	Value	Limit	
THC @ 7%	28.6	100	[ppm]
Chmbr	1368	1311	[Deg
Scrb dP	24.0	24.60	["WC]
Scrb pH	6.4	6.50	[pH]
Scrb	864.0	0	[GPM]

Sludge Feed	[Tons/Hr]	5.335
Damper	1=Open	0

Quad M

SrcStat	Proc On	SU/SD	In Maint	In Cal	CE > 2	CE > 4
1	On	Off	Normal	Normal	CE OK	CE OK

Status Codes

<=OK B=Bad C=Cal d=Src D=Maint X=OOC S=Inst M=Missing

Station	Group	Channel	Alarm	Value	Status	Start	Ack.

APPENDIX B

Technical Information on Measurement Equipment

- **Temperature Measurement Devices**
- **Flow Measurement Devices**
- **Pressure Measurement Devices**
- **pH Measurement Devices**
- **Scales**

Warren WWTP Part # 1K1BKU22WP7(4)GZA for 22" long probe. Substitute 20 for 22 for 20" probe.

MINIATURE AND INDUSTRIAL THERMOCOUPLES

#1	DESCRIPTION [6, 7]
1	Thermocouple

#2	TYPE [8, 9, 10]
–"	J, T, K, E, N, X (Other, specify)

#3	LIMITS OF ERROR [9]	ELEMENT CONSTRUCTION
1	Standard	Single
2	Standard	Dual
3	Special	Single
4	Special	Dual
X	Other, specify	

Note: For hollow tube sensors see pages 2-1 and 2-2.

#4	OUTSIDE DIAMETER [11]	CONDUCTOR SIZE (FOR BASE METALS ONLY) SINGLE (AWG)	DUAL (AWG)
A*	3/8"	13	16
B	1/4"	16	18
C	3/16"	19	20
D	1/8"	22	24
E	1/16"	28	30
F*	1/25"	32	34
X	Other, specify		
Z	N/A		

Note: JMS now offers sheath as small as .010 in diameter

#5	SHEATH MATERIAL [11]	MAX °F	[2-8, 4-17]		MAX °F
H	304 Stainless Steel	1650	M	Inconel 600	2100
J	310 Stainless Steel	2100	C	Teflon coated SS	400
V	STABALOY	2220	Q	Hastelloy C-276	2000
K	316 Stainless Steel	1650	X	Other, specify	

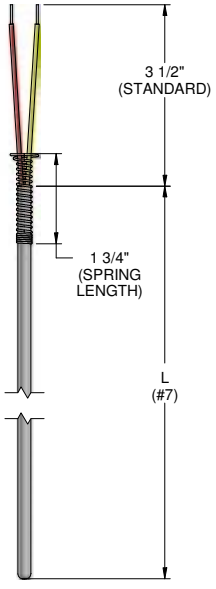
[ ] BRACKETS INDICATE PAGE NUMBERS IN TECHNICAL CATALOG AVAILABLE ONLINE AT WWW.JMS-SE.COM/PDF/JMS_TECHNICAL_CATALOG.PDF

#6	MEASURING JUNCTION [12, 13, 14, 15]		
G	Grounded	P*	Reduced tip, grounded
U	Ungrounded	Y*	Reduced tip, ungrounded
E	Exposed (Isolated on dual)	R*	Gas/Air, exposed
I	Isolated	S*	Gas/Air, grounded
J*	Pointed tip, grounded	T*	Gas/Air, ungrounded
K*	Pointed tip, ungrounded	V*	Enlarged tip, grounded
L*	Weld pad, grounded	W*	Enlarged tip, ungrounded
M*	Weld pad, ungrounded	X*	Other, specify
N*	Weld pad, removable grounded		
O*	Weld pad, removable ungrounded		

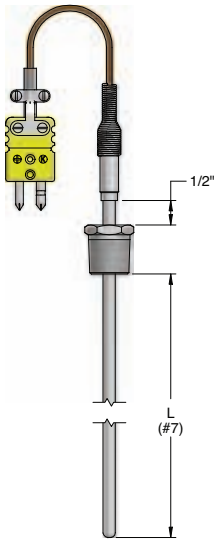
* **Note:** Provide description when selecting these options.

Note: For options N & O Fasttrax designs refer to 4-15.

#7	LENGTH (See sketches on Pg. 1-1, 2, & 3 for lengths)
--"	Length in inches **Note:** If sensor requires factory bend order from pg 2-1.



Immersion for Symbol #8-E Spring



Immersion for Symbol #8-G&D Fitting

#8	STANDARD INDUSTRIAL ATTACHING DEVICE [1-3, 6-13]
W	Fixed NPT ss fitting - double threaded
S	Spring loaded NPT ss fitting -double threaded
C	Spring loaded NPT ss w/ oil ring - double threaded
D	Spring loaded ss fitting - single threaded
M**	CSA explosion proof spring loaded fitting
A	Spring loaded w/threaded retainer
B	Bayonet spring loaded assembly for thermowells and heads
E*	Adjustable spring over .250", .188", .125" sheath
F	Reverse mounted steel plug fixed for attaching head
G	Fixed stainless steel to sheath (See drawing to left)
H*	Compression fitting ss w/ ss ferrule
I*	Compression fitting ss w/ teflon ferrule
J*	Compression fitting ss w/ lava ferrule
K*	Compression fitting ss w/ nylon ferrule
L*	Compression fitting brass w/ brass ferrule
H4	4" SS nipple-union-nipple (NUN4H1)
H6	6" SS nipple-union-nipple (NUN6H1)
N4	4" nipple-union-nipple (NUN4G1)
N6	6" nipple-union-nipple (NUN6G1)
S4	4" spring-loaded-union-nipple (NU4G1)
S6	6" spring-loaded-union-nipple (NU6G1)
C4**	4" CSA certified flame path spring-loaded-union-nipple
C6**	6" CSA certified flame path spring-loaded-union-nipple
X	Other, specify or if more than 1 is needed
Z	Not applicable (no fitting required)

(See pgs 1-3 for more nipple options.)

1	J	1	B	H	G	12"	S

* Length calc. w/out attaching device.(See dwg on pg. 1-2)
**For CSA certified assbly. sensor must be assembled w/thermowell having appropriate Canadian Registration Number (CRN)

MINIATURE AND INDUSTRIAL THERMOCOUPLES

#9 PROCESS NPT [3]

L	1/8”
M	1/4”
P	1/2” (Standard w/ symbols W, S, C, and N in symbol #8)
O	3/4”
X	Other, specify
Z	N/A

#10 LEAD WIRE TYPE & LENGTH IN INCHES [SEE SECTION 7]

Z	No lead wires
1__”	Glass braid
2__”	PVC
3__”	Teflon
4__”	Hi-temp glass braid
5__”	Kapton

} Solid 20 AWG

7__”	Bare wire
8__”	PVC coil cord - Standard when using symbol #8-B and #13-R
X__”	Other, specify

Note: For stranded wire,add ”S” before symbol designation in this column. 24 awg or smaller may be used to accommodate some smaller diameters and flex armor extensions.

#11 ARMOR OR HEAT SHRINK [7-7] [16]

A	3/16” ID SS flex armor
B	3/16” ID SS flex armor teflon coated white
C	3/16” ID SS flex armor teflon coated black
D	1/8” ID SS flex armor
F	SS overbraid
G	Heat shrink / sleeving
H	Jacket to match primary insulation

J	Aluminum mylar shielded and jacketed to match primary insulation
X	Other, specify
Z	N/A

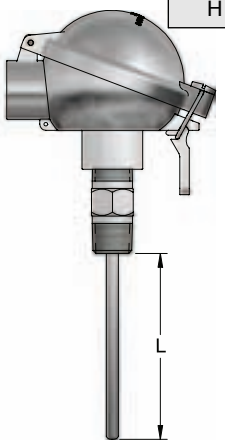
Note: Bell Springs are used for most wire extensions at transition. A special armor adapter is used when armor is longer than 60”.

#12 TYPE OF TRANSITION [16]

H	Heat shrink
S	Size on size
T	3/8” OD (Standard)
R	1/4” OD
Q	Cuttable (see full catalog)
X	Other,specify
Z	No transition

Note: For high humidity / moisture environments, ≤ 500˚F put a “2” after your selection.

Note: For high temperature at the transition area use an X + type of transition and maximum temperature. >500°F

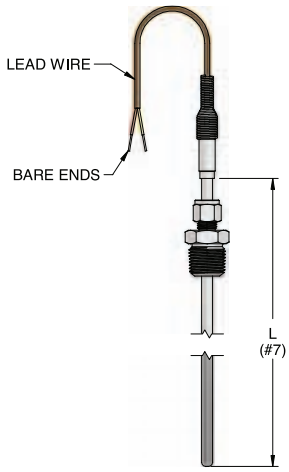


#13 COLD END TERMINATION [SEE SECTION 6] PICK AS MANY AS APPLICABLE

A	Bare ends
B	Miniature plug
C	Standard plug
D	Miniature jack
E	Standard jack
F	High temperature plug (< 800˚ F)
G	High temperature jack (< 800˚ F)
I	Explosion proof NEMA 4X head, FM, CSA (6IA/6B4)
J	Explosion proof stainless steel NEMA 4X head, FM, CSA (6ISS/6B4)
K	Spade lugs (6SL)
L	Aluminum head w/ hinged cover (6L / 6B4)
M	Aluminum head w/ screw cover & chain (6M / 6B4)
N	Cast iron head w/ screw cover (6N / 6B4)
O	Open terminal block (6M)
P	Explosion proof AL head ATEX certified
U	Explosion proof stainless steel head ATEX certified

Note: For any other cold end termination, use symbol X and describe using appropriate part numbers from section 6 in place of symbol #13.

Q	Blk nylon Nema 4 head (6Q/6B4)
R	High dome head (6R)
WM	Microphone style connector (6DA) -Male
WF	Microphone style connector (6DA) -Female
8H	Isolated transmitter
8N	Non isolated transmitter
8S	AI-1500
8I	TempIR with Hart Protocol
8E	Intrinsically Safe TempIR
8D	TempIR/ Hart/ Intrinsically Safe
X	Other, specify



Immersion is overall length of tube for non-fixed attaching devices

#14 OPTIONS USE ONLY IF APPLICABLE [INTRODUCTION]

1*	Stainless steel tag
2*	Plastic tag
3*	Paper tag
4*	Laser etch on probe

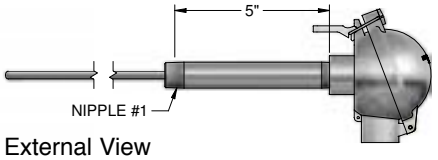
* Must specify information required on tag / to be etched

5	Calibrate at specified point(s). Corrections data will be provided for each point.
6**	Premium calibration report Corrections data will be provided for all temperatures within the range.
7	CE Marking [Page XV]
8	Guide 17025 calibration
9	BAR CODE
Z	N/A

** You must specify increments & range (Ex. 0 to 300°F, 10° increments)

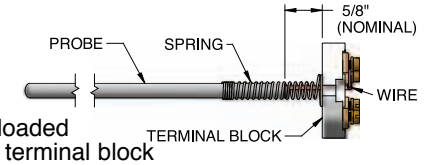
P	Z	Z	Z	L	1

NIPPLE-UNION-NIPPLE EXTENSION ASSEMBLIES

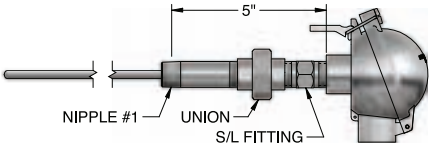


External View

Drawing 1
Nipple + Adjustable Spring
Minimum Nipple L =1"
Ex. Part#: 1J1BHG12"EXZZZL
X = N5"G1

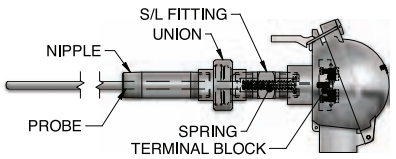


Spring loaded
against terminal block

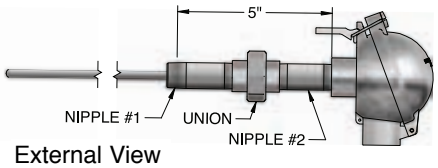


External View

Drawing 2
Nipple-Union with Machined
1/2" x 1/2" Spring Loaded Fitting
Minimum NU L = 3 1/2"
(includes S/L fitting)
Ex. Part#: 1J1BHG12"SXZZZL
X = NU5"G1

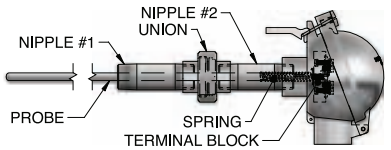


Internal View



External View

Drawing 3
Nipple-Union-Nipple with
Spring Against Terminal Block
Minimum NUN L = 2 1/2"
EX. Part#: 1J1BHG12"EXZZZL
X = NUN5"G1



Internal View

An extension assembly may be needed to provide extra length for your sensor in order to extend your sensor head through insulation, or away from the heat of the process. This extension can include a pipe nipple only or a nipple-union-nipple or a nipple-union with a spring-loaded fitting.

Standard nipples and unions are 1/2" NPT and are available in galvanized or stainless steel. The union joins two nipples in an extension assembly and has a standard pressure rating of 150 pounds.

When a nipple-union-nipple or nipple only assembly is used and spring loading of the thermocouple element is required, there are two different methods of spring loading the sensor.The preferred method is to use the machined 1/2" by 1/2" NPT spring-loaded stainless steel fitting as one of the nipples. With this design, the probe is secured within the fitting and is mounted to the head in a rigid manner (see drawing #2 above). The appropriate part number for this assembly would be selected from symbols #8 and #9 from page 1-1 and 1-2, in addition to the symbols on this page. A cheaper method is a spring, mounted over the probe and loaded against the bottom of the terminal block in the head. With this method the probe is not supported within the nipple-union-nipple. It is secured only by the wires into the terminal block. (See drawings 1 & 3 above). We do not recommend that you use this method of spring loading.

When specifying this sensor extension, the nipple-union-nipple length tolerance is ± 1/2".

#1	EXTENSION ASSEMBLY
N NU NUN	Nipple Only (Dwg #1) Nipple-Union (Dwg #2) Nipple-Union-Nipple (Dwg #3)

#2	LENGTH
--"	Specify length in inches

#3	MATERIAL
G H C	Galvanized Steel 304 Stainless Steel Black Steel

#4	PRESSURE RATING	
1 2 3 X	#150 - A351 spec (Standard) #3000 - A182 spec #6000 - A182 spec Other, specify	ASTM

NUN	5"	G	1

Our Model is 8HK (32)-(2300) F4ZZ

New in 2020:
JMS 8H Isolated
PC-Programmable Universal, 2-wire Transmitter (USB)

The JMS 8H transmitter is a universal, isolated, temperature transmitter with additional voltage and resistance input. Its robust design and high quality gives excellent performance and accuracy also under harsh conditions. The 8H is available with Ex certificates making it suitable for a wide range of applications.

With the new runtime function you can easily supervise the elapsed operational time between calibrations.

High accuracy
With an accuracy of ±0.08 °C or ±0.08 % of span 8H offers a high performance in its class.

Long term stability
With a drift over 5 years of maximum of ± 0.1°C or ±0.1% of span makes regular calibration less necessary.

Low temperature drift
8H have a very low temperature drift of ±0.01°C per °C or ±0.01% of span per °C.

High safety
It offers excellent EMC performance and compliant to Namur NE21, NE43, NE53 and NE107 together with different Ex approvals.

Designed for harsh conditions
Rugged design tested for 10 g vibrations.

High user efficiency
The user friendly JMS software is used for transmitter configuration in seconds with window based parameters, such as measuring range, sensor failure action, error-corrections, TAG etc.

Configuration without external power
Edit or read the configuration off-line, i.e. without power supply, by just connecting the USB-interface to a PC.

Security
Configuration is password protected and date of changes logged.

Runtime counter
With the runtime counter function you can for example easily supervise the elapsed operational time.

JMS Southeast, Inc. 105 Temperature Lane, Statesville, NC 28677 Phone: 1-800-872-1835 Email: sensors@jms-se.com
Web: www.jms-se.com

Other features of the 8H transmitters

Basic accuracy and long-term stability

The combination of a high-efficient 50-point linearization or Callendar-Van Dusen equation and an electronic design based on the most precise and "zero-drift" technology results in a high basic accuracy and excellent long-term stability. The drift over 5 years is guaranteed to maximum of ±0.1°C or ±0.1 % of the measuring span.

Ambient temperature stability

Features like background calibration of the input converter in every measurement cycle have strongly reduced the ambient temperature influence to a minimum.

Customized linearization

For resistance and mV inputs, either a 50-point Customized Linearization table or via Callendar-Van Dusen constants can provide a correct process value, in a choice of engineering units, for a sensor with non-linear input/output relation.

Adjustable filtering

For handling of instabilities or disturbance on the input, an adjustable filtering level can be used.

Sensor and system error-correction increases the accuracy

This function compensates for deviations in connected sensors or the complete system including the transmitter error. A reduction of the total measurement error, for the sensor and transmitter combination, of more than 50 % is typical.

Measurements with RTD's and potentiometers

The 8H transmitters accept inputs from standardized Platinum RTDs acc. to IEC 60751 and JIS C 1604, Nickel RTD's acc. to DIN 43760 and Cu10 acc. to Edison Cu Windings No. 15.
Input for plain resistance and potentiometers, up to 10000 Ω is available.
2-, 3- or 4-wire connection can be chosen (See Input connections below).

Measurements with Thermocouples and voltage

The 8H transmitters accept inputs from 10 types of standardized thermocouples as well as plain mV input up to 1000 mV.
For T/C input, the CJC (Cold Junction Compensation) is either fully automatic, by means of an internal accurate sensor, external with Pt100 sensor or fixed by entering an external CJ temperature.

JMS configuration software

The PC configuration software is a versatile and user-friendly tool for transmitter configuration, loop check-up and sensor diagnostics. All features described in this data sheet are handled in a simple and fail-safe way. JMS software is part of the complete Configuration Kit, which also contains a USB Interface and necessary cables.

Specifications

Input RTD

Pt100	(IEC 60751, α=0.00385)	-200 to +850 °C
Pt X (10 ⩽ X ⩽ 1000)	(IEC 60751, α=0.00385)	Corresp. to max. 4000 Ω
Pt100	(JIS C 1604, α=0.003916)	-200 to +850 °C
Ni100	(DIN 43760)	-60 to +250 °C
Ni120	(Edison Curve No. 7)	-60 to +250 °C
Ni1000	(DIN 43760)	-50 to +180 °C
Cu10	(Edison Copper Windings No. 15)	-50 to +200 °C
Input connection		See "Input connections" below
Sensor current		⩽300 µA
Maximum sensor wire resistance	3- and 4-wire connection	20 Ω/wire
	2-wire connection	Compensation for 0 to 40 Ω loop resistance

Input Resistance / Potentiometer

Range, resistance	0 to 10000 Ω
Range, potentiometer	100 to 10000 Ω
Minimum span	10 Ω
Customized linearization	Up to 50 points
Sensor current	⩽300 µA
Input connections	See "input connections" below
Maximum sensor wire resistance	20 Ω / wire

Input Thermocouple

T/C B	Pt30Rh-Pt6Rh (IEC 60584)	400 to +1800 °C
T/C C	W5-Re (ASTM E 988)	0 to +2315 °C
T/C D	W3-Re (ASTM E 988)	0 to +2315 °C
T/C E	NiCr-CuNi (IEC 60584)	-200 to +1000 °C
T/C J	Fe-CuNi (IEC 60584)	-200 to +1000 °C
T/C K	NiCr-Ni (IEC 60584)	-200 to +1350 °C
T/C N	NiCrSi-NiSi (IEC 60584)	-250 to +1300 °C
T/C R	Pt13Rh-Pt (IEC 60584)	-50 to +1750 °C
T/C S	Pt10Rh-Pt (IEC 60584)	-50 to +1750 °C
T/C T	Cu-CuNi (IEC 60584)	-200 to +400 °C
Input impedance		>10 MΩ
Input connections		See "Input connections" below
Maximum wire loop resistance		500 Ω (Including T/C sensor)
Cold Junction Compensation (CJC)		Internal, external (Pt100) or fixed

Input Voltage

Range	-10 to +1000 mV
Minimum span	2 mV
Customized linearization	Up to 50 points
Input impedance	>10 MΩ
Input connections	See "Input connections" below
Maximum wire loop resistance	500 Ω

General input

Zero adjustment	Within range
Max offset adjustment	50% of selected max value

Note: All sensor types measure maximum another 10°C of specified min/max sensor values

Output

Output signal	4-20 mA, 20-4 mA Temperature linear for RTD & T/C
Update time	~150 - 300 ms
Resolution	0,4 µA
Uncertainty	1 µA
Adjustable output filtering	0,15 to 75 sec (3-wire RTD)
Permissible load	750Ω @ 24 VDC
NAMUR Compliance	Current limitations and failure currents acc. to NAMUR, NE 43

Sensor Failure Effects

Output control acc. to NAMUR NE 43	Individual upscale/downscale action for Sensor break and Sensor short-circuit
Status information via ConSoft acc. to NAMUR NE 107	Sensor break and Sensor short-circuit

General data

Isolation	1500 VAC, 1 min
Power supply, polarity protected	8 to 36 VDC
Line rejection	50 Hz to 60 Hz line rejection

Ex Approvals IPAQ C330X

ATEX	II 1 G Ex ia IIC T6...T4 Ga
IECEx	Ex ia IIC T6...T4 Ga
FM	Ex ia IIC T6...T4 Ga
CSA	Ex ia IIC T6...T4 Ga

Environment conditions

Ambient temperature	Storage	-40 to +85 °C
	Operating	-40 to +85 °C
Humidity		0...98% RH (non-condensing)
Vibration		Acc. to IEC 60068-2-6, test Fc, 10 to 2000 Hz, 10 g
Shock		Acc. to IEC-60068-2-27, test Ea
Rough Handling		Acc. to IEC-60068-2-31:2008, test Ec
EMC	Standards	Directive: 2014/30/EU Harmonized standards: EN 61326-1, EN 61326-2-3 NAMUR NE 21
	Immunity performance	EN61326-1 and -2-3: Criteria A NE 21: <0,5% of span

Housing

Mounting		DIN B head or larger, DIN-rail (with adapter)
Material, Flammability acc. to UL		PC/ABS + PA, V0/HB, RoHS compliant
Connection	Single/stranded wires	Max. 1.5 mm², AWG 16
Weight		35g
Protection, housing / terminals		IP 65 / IP 00

Accuracy and stability

Basic accuracy	RTD and Thermocouple	See table below
	Resistance Digital accuracy [1]	0-1000 Ω: Max of ±40 mΩ or ±0.040 % of span
		1000-10000 Ω: ±0.05 % or max 1 Ω of span
	Resistance Analog accuracy [1]	±0.06 % of span
	Voltage Digital accuracy [1]	±5 µV or ±0.02 % of span
	Voltage Analog accuracy [1]	±0.06 % of span
Temperature influence	RTD and Thermocouple	See table below
	Resistance	±0.01 % < 4000 Ω [2] < ±0.02 % of span per °C
	Voltage	±0.01 % of span per °C
Cold Junction Compensation (CJC)		±0.5 °C within ambient temperature -40 to +85 °C
Temperature influence CJC		±0.01 °C per °C
Sensor wire influence	RTD and Resistance, 2-wire	Adjustable wire resistance compensation
	RTD and Resistance, 3-wire	Negligible, with equal wire resistance
	RTD and Resistance, 4-wire	Negligible
	Thermocouple and Voltage	Negligible
Supply voltage influence	Within specified limits	<±0.005 % of span per V
Long-term drift		Max of ±0.02 °C or ±0.02 % of span per year

[1] Total accuracy = Sum of digital and analog accuracy, calculated as an RMS (Root Mean Square) value

[2] 2000 Ω at 2-wire

Accuracy specifications and minimum spans for RTD and Thermocouples

Conformance level 95 % (2σ)

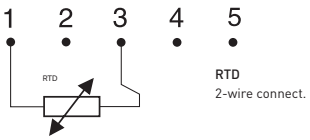
Input type	Temperature range	Minimum span	Accuracy	Temperature Influence
			Maximum of:	*(Deviation from ref. temp. 20 °C)*
RTD Pt100	-200 to +850 °C	10 °C	±0.08 °C or ±0.08 % of span	±0.01 % of span per °C
RTD PtX [1]	Corresp. to max. 4 kΩ	10 °C	±0.1 °C or ±0.1 % of span	±0.01 % of span per °C [3]
RTD Ni 100	-60 to +250 °C	10 °C	±0.1 °C or ±0.1 % of span	±0.01 % of span per °C
RTD Ni 120	-60 to +250 °C	10 °C	±0.1 °C or ±0.1 % of span	±0.01 % of span per °C
RTD Ni 1000	-50 to + 180 °C	10 °C	±0.1 °C or ±0.1 % of span	±0.01 % of span per °C [3]
RTD Cu10	-50 to +200 °C	83 °C	±1.5 °C or ±0.2 % of span	±0.01 % of span per °C
T/C type B	+400 to +1800 °C	700 °C	±1 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type C	0 to +2315 °C	200 °C	±1 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type D	0 to +2315 °C	200 °C	±1 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type E	-200 to +1000 °C	50 °C	±0.5 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type J	-200 to +1000 °C	50 °C	±0.5 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type K	-200 to +1350 °C	50 °C	±0.5 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type N	-100 to +1300 °C	100 °C	±0.5 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type N	-250 to -100 °C	100 °C	±1 °C [2]	±0.1 % of span per °C
T/C type R	-50 to +1750 °C	300 °C	±1 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type S	-50 to +1750 °C	300 °C	±1 °C or ±0.1 % of span [2]	±0.01 % of span per °C
T/C type T	-200 to +400 °C	50 °C	±0.5 °C or ±0.1 % of span [2]	±0.01 % of span per °C

[1] (10 ≤ X ≤ 1000)

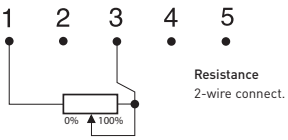
[2] CJC error is not included

[3] ±0.02 % at 2-wire > 2000 Ω of span per °C

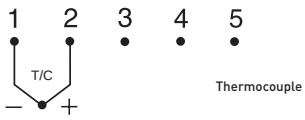
Input connections



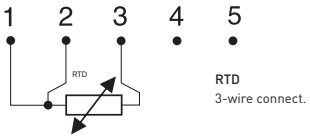
RTD
2-wire connect.



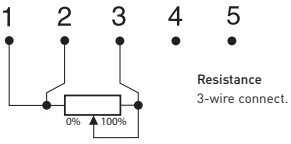
Resistance
2-wire connect.



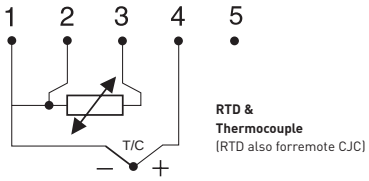
Thermocouple



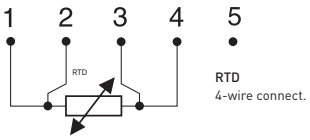
RTD
3-wire connect.



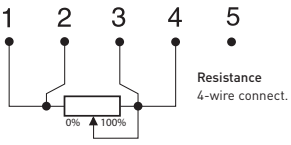
Resistance
3-wire connect.



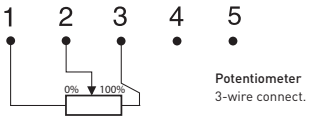
RTD &
Thermocouple
(RTD also forremote CJC)



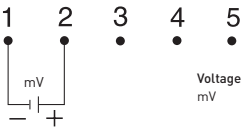
RTD
4-wire connect.



Resistance
4-wire connect.



Potentiometer
3-wire connect.

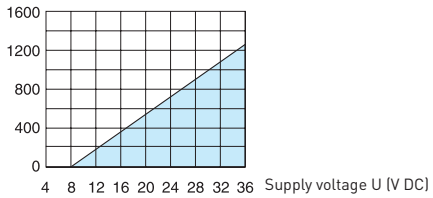


Voltage
mV

Output load diagram

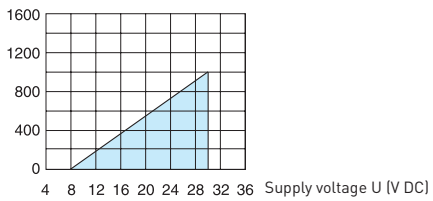
Standard version

$R_{LOAD}(\Omega) = (U-8)/0.022$

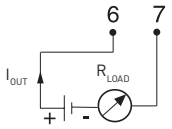


Ex version

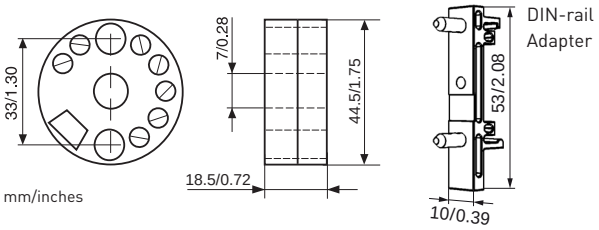
$R_{LOAD}(\Omega) = (U-8)/0.022$



Output connections



Dimensions



mm/inches

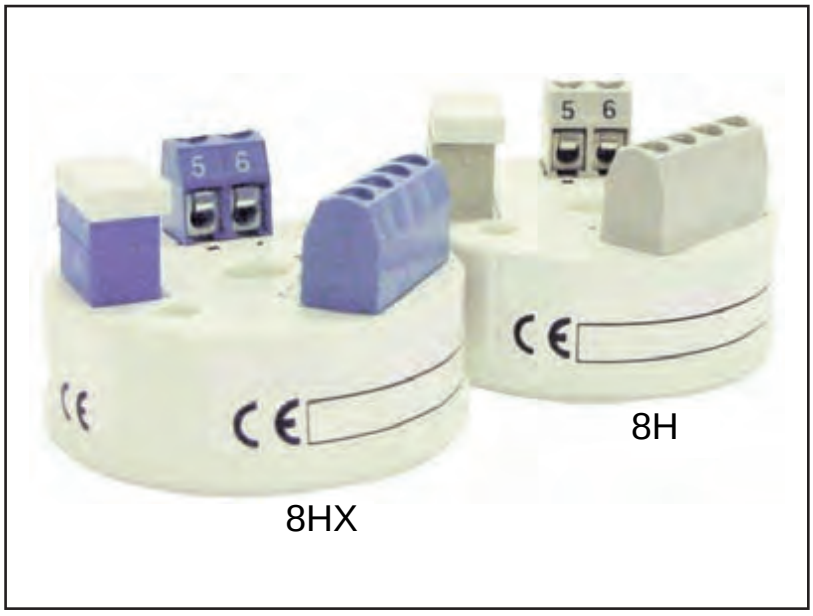
Notes

2020 & EARLIER ISOLATED TRANSMITTERS

The JMS 8H, I, and E series isolated transmitter (TempIR) is a 2-wire loop-powered intelligent transmitter. Small size and extreme versatility makes the TempIR an ideal choice for all industrial instrumentation. The transmitter is manufactured for inputs from a wide range of RTD's, thermocouples, plain mV, and resistance. A customized linearization can easily be generated.

A wide power supply range allows for high load in the output loop, e.g. long output leads and multiple instruments. TempIR is configured with TemPRO, the general software to configure the entire temp-family. The program is Windows driven and easy to use. The configuration can be performed on-line, with in and outputs connected. While receiving new parameters, the transmitter will freeze the output signal and return to normal operation after completed transmission of the new parameters.

The 8H series transmitters are microcontroller based and do multiple measurements beyond the standard measurements. One of these controls is to monitor the isolation resistance of the sensor and the sensor leads. This function named, TempIRsense, is available for thermocouples and 3-wire RTD's (see page 8-25 and 8-26 for a technical note).



Performance and design:

- **Excellent stability**
  Long-term stability 0.1% / year.
- **Enhanced total system accuracy**
- **Input-output isolation 1500 VAC**
  Eliminates measuring errors due to ground loops.
- **High load capacity**
  Only 6.5 V voltage drop over the transmitter allows for high loads.
- **Designed for harsh conditions**
  Operation temperature: -40 to +85°C, -40 to +185°F.
  Excellent EMC performance.
  Durable, shockproof design.
- **Simplified mounting and connection**
  For DIN B head or larger.
  Large center hole (dia. 7mm / 0.28 inch).

Standard Inputs for:

- **RTD's, Thermocouples, mV and resistance**
  Reduced inventory costs.
  Simplified plant engineering.
- **True on-line configuration**
  Full access to all features while in operation.
- **Customized 40 point linearization**
- **TempIRsense, unique monitoring of insulation resistance**
  Detects low sensor isolation (see below).
  Selectable sensor break action.
- **Simplified loop check-up**
  The transmitter works as an accurate current generator.
- **Easy to configure**
- **On-screen indications and line recording**
  Valuable tools for temporary measurements.

ISOLATED TRANSMITTERS

Specifications

Input		
Pt100	3, 4 wire	-200 to +1000°C -328 to +1832°F
Pt1000	3, 4 wire	-200 to +200°C -328 to +392°F
Ni100	3, 4 wire	-60 to +250°C -76 to +482°F
Ni1000	3, 4 wire	-60 to +150°C -76 to +302°F
Potentiometer	3, 4 wire	0 - 2000Ω
Sensor Current		approx. 0.4mA
mAx. Permissible Lead Resistance		25 Ω/lead

Thermocouples & Voltage	
T/ C	B, E, J, K, L, N, R, S, T, U
Voltage Input	-10 -500 mV
Input Resistance	>10 Mohm
Total permissible lead resistance for both input leads	500 ohms

Monitoring	
	User definable settings
Sensor break detection	3.5 - 22.8 mA
TempIRsense, sensor isolation monitoring	3.5 - 22.8 mA

Adjustments		
Zero adjustments		no limitation
Minimum ranges	Pt100, Pt1000	
	Ni100, Ni1000	10°C, 18°F
	Potentiometer	10Ω
	T/C, mV	2 mV

Output	
Straight, reversed or any intermediate value	4 - 20 mA
Resolution	5μA
Min output signal	appr. 3.5mA
Max output signal	appr. 23 mA

General Data		
Selectable filter time for low pass filter		0-60 s
Scan time		appr. 0.5 s
Rise time	10 -90 %	appr. 0.3 s
Transformer Isolation In- Out		1500 VAC 1 min

Power Supply	
Power supply polarity protected	6.5-36 VDC 10-36 VDC

Accuracy		
Linearity	RTD, mV T/C	0.05%[1] 0.1%[1]
Calibration	Pt100, Pt1000 Ni100, Ni1000 Potentiometer mV, T/C	The larger of 0.1°C 0.2°F or 0.05%[1] The larger of 0.1Ω or 0.5%[1] The larger of 20μV or 0.05%[1]
Cold Junction Compensation	T/C	0.5°C, 0.9°F
Temperature Drift		The larger of 0.005 °C/°C, 0.005 °F/°F or 0.005 %/°C, 0.003%/°F
Cold Junction Compensation	T/C	0.02°C/°C, 0.02°F/°F
Lead Wire Resistance Influence:		
RTD 3-wire		See Table 1
RTD 4-wire		negligible
Thermocouple		negligible
Load influence		negligible
Power supply influence		negligible
Long term drift, 25°C, 77°F		typ 0.1%[1]/year

Temperature	
Ambient Temperature	-40 to +85°C -40 to +185°C

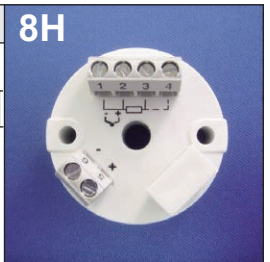
Emission, EN 50081-2 Industrial Environment	30-230 MHz, 30dB (μV/m) 230-1000MHz, 37dB (μV/m)
Immunity, EN50082-2 Industrial Environment	RF, air, 80-1000MHz, AM RF, air, 900 MHz, pulse modulated (GSM cellular telephone) RF, cables, 0.15-80 MHz, ESD 4kV contact, 8kV contact, 8kV air discharge Fast transients, cables, 2kV
HF immunity tested for 10v/m	up to 1000MHz

Housing	
Material	PC +ABS, UL V0
Mounting	DIN B-head or larger
Weight	appr. 50g

[1] selected maximum signal

ISOLATED TRANSMITTERS

#1	DESCRIPTION [8-14 through 8-17]
8	Transmitter (Add "R" for DIN rail style for transmitter)



#2	TYPE OF TRANSMITTER	I/O ISOLATION	SUPPLY VOLTAGE
H	Standard	1000 VAC	12 to 35 VDC
I	Hart Protocol	2500 VAC	11 to 30 VDC
E	Intrinsically safe	2500 VAC	11 to 30 VDC
D	Intrinsically safe/Hart Protocol	2500 VAC	11 to 30 VDC
X	Other, specify		

#3	INPUT		
J	Iron/Constantan thermocouple	N	Nicrosil/Nisil thermocouple
T	Copper/Constantan thermocouple	C	Tungsten 5% Rhenium/Tungsten 26% Rhenium T/C
K	Chromel/Alumel thermocouple	2	100Ω, Platinum, a=.00385, RTD, 2 Wire
E	Chromel/Constantan thermocouple	3	100Ω, Platinum, a=.00385, RTD, 3 Wire
S	Platinum 10% Rhodium/Pure Platinum thermocouple	4	100Ω, Platinum, a=.00385, RTD, 4 Wire
R	Platinum 13% Rhodium/Pure Platinum thermocouple	X	Other, specify
B	Platinum 6% Rhodium/Platinum 30% Rhodium T/C	Z	N/A

#4	TEMPERATURE RANGE		
_ to _°C	List desired temperature span	X	Other, specify
_ to _°F	List desired temperature span	Z	N/A (customer to span)

#5	OUTPUT		
1	1 to 5 VDC	F	Fieldbus
4	4 to 20 mA	X	Other, specify
P	Profibus		

#6	SOFTWARE & CABLES INCLUDED?
A	Yes
Z*	No

*Standard for I, E, & D type transmitters.

#7	PLUG IN INDICATION		
P*	Yes	Z	No

* Only available with "puck" styled models I, E, or D in selection #2.

Note: DIN rail style(8R) available for all isolated transmitter types.

For more information and details on transmitters, Visit www.JMS-SE.com/Transmitters

ADDITIONAL TERMINATIONS

	COLD END TERMINATION [SEE SECTION 6] Choose as many as applicable (JMS part number prefixes are shown in parenthesis)		
Connectors			
	Plugs		**Jacks**
B	Miniature plug (6A1B)	D	Miniature jack (6A1D)
BH	Miniature high temperature plug (6A2B) <800°F	DH	Miniature high temperature jack (6A2D) <800°F
C	Standard plug (6A1C)	E	Standard jack (6A1E)
F	Standard high temperature plug (6A2C) <800˚F	G	Standard high temperature jack (6A2E) <800˚F
WM	Microphone style plug (6DA)	WF	Microphone style jack (6DA)
WA	Solid pin plug, heavy duty (6A3C)	WB	Solid pin jack, heavy duty (6A3E)
WC	Jab in plug (6A4C)	WD	Jab in jack (6A4E)
WE	Ultra high temperature plug, glazed (6A5C) <1200°F	WG	Ultra high temperature jack, glazed (6A5E) <1200°F
WH	Ultra high temperature plug, unglazed (6A7C) <1200°F	WI	Ultra high temperature jack, unglazed (6A7E) <1200°F
WJ	Low noise plug (6A6C) <425°F	WK	Low noise jack (6A6E) <425°F
WL	DIN-IEC microphone plug (6DB)	WN	DIN-IEC microphone style jack (6DB)
V	Molded/hermetic plug (6DC)	VF	Molded/hermetic jack (6DC)
Y	M12 Male connector (6DY)	YF	M12 Female connector (6DY)

Heads [6–1] Visit *www.JMS-SE.com/headspecs*

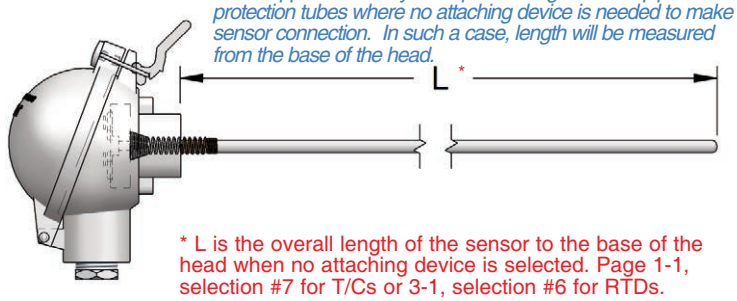
Explosion Proof

I	Aluminum, NEMA 4X, FM, CSA, IP66 (6IA/6B4)
J	316 stainless steel, NEMA 4X, FM, CSA, IP66 (6ISS/6B4)
P	Aluminum, NEMA 4X, FM, CSA, ATEX, IECEx, IP66 (6IAIEC/6B4)
U	316 stainless steel, NEMA 4X, FM, CSA, ATEX, IECEx, IP66 (6ISSATEX/6B4)
SI	Cast Iron, NEMA 3, 4, UL, CSA (6I/6PT)
GA	Aluminum, screw cover w/ indicating window, NEMA 4X, ATEX, IECEx, FM, CSA, IP66 (688A1)
GS	316SS, screw cover w/ indicating window, NEMA 4X, ATEX, IECEx, FM, CSA, IP66 (688S1)

General Purpose

L	Aluminum w/ hinged cover (6L/6B4)
M	Aluminum w/ screw cover & chain (6M/6B4)
R	Aluminum w/ hinged high dome cover (6R/6B4)
N	Cast Iron w/ screw cover (6N/6B4)
Q	Black Noryl plastic (6Q/6B4)
SS	316 stainless steel w/ screw cover & chain (6SS/6B4)
WP	White plastic, screw cover, Sanitary (6WP, 6B4)
SB	Nickel plated, cylinder style, 1/4" NPT (6S250)
SD	Nickel plated, cylinder style, 1/8" NPT (6S125)
SC	Stainless steel, socket cap style
ST	Molded plastic, mini head, 1/4" NPT, < 350F (6T)
SU	Molded plastic, mini head, 1/4" NPT, < 800F (6U)

Some applications may have pre-existing threaded pipes or protection tubes where no attaching device is needed to make sensor connection. In such a case, length will be measured from the base of the head.



* L is the overall length of the sensor to the base of the head when no attaching device is selected. Page 1-1, selection #7 for T/Cs or 3-1, selection #6 for RTDs.

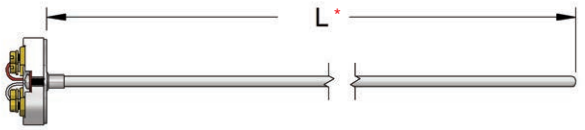
Transmitters

8H	Isolated transmitter
8N	Non-isolated transmitter
8I	Hart Protocol
8E	Intrinsically safe
8D	Hart/Intrinsically safe
8M	Integral transmitter (see page 3-5) RTDs ONLY

Notes:
- Add span range after transmitter selection. Example: 8H(0-200C).
- Transmitter output = 4 - 20 mA. (See section 8 for other options).

Other

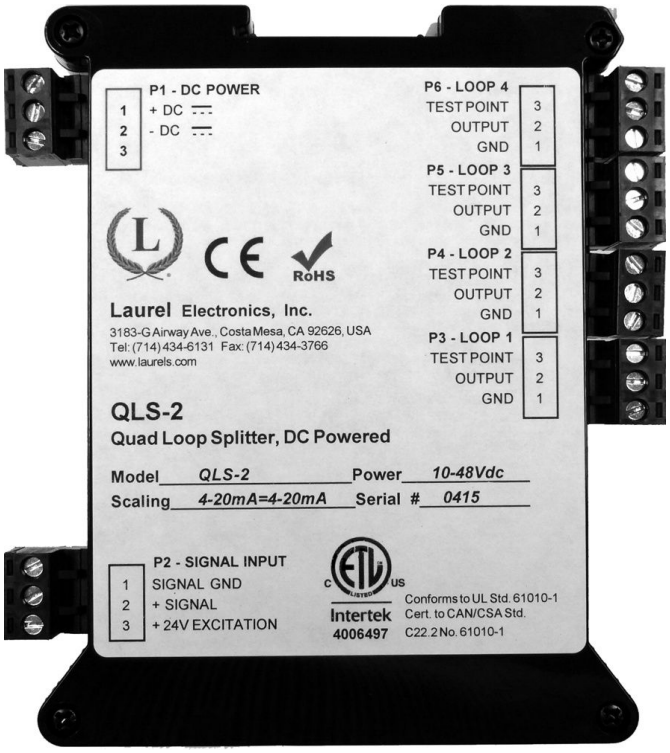
A	Bare ends
K	Spade lugs (6SL)
RL	Ring lugs (6RL)
O	Open ceramic terminal block, Brass screw terminal (6B)
OA	Open Bakelite terminal block, Nickel plated screw terminal (6BB)
OB	Open ceramic terminal block for sensors with bayonet style connection, Brass screw terminal (6B or 6C/6DMD)
OG	Ceramic terminal block, Brass screw terminal (6G)
OP	Pluggable Polymide terminal block, Nickel plated screw terminal (6PT
OS	Open ceramic terminal block, Nickel plated solder terminal (6C)
CG	Cord connector/grip, Aluminum 1/2" NPT (6CC)
PS	Ship straight
X	Other, specify



* L is the overall length of the sensor to the base of the terminal block mounting plate when open terminal block cold end termination is selected without a fixed attaching device. Page 1-1, selection #7 for T/Cs or 3-1, selection #6 for RTDs.

QLS Quad Output 4-20 mA Current Loop Splitter / Retransmitter

With ±10V common mode isolation between input & outputs



RoHS

CE

C ETL US LISTED
Intertek
4006497

LAUREL Electronics Inc.
3183-G Airway Ave, Costa Mesa, CA, 92626, USA
Tel: (714) 434-6131 Fax: (714) 434-3766 Website: www.laurels.com

1. ORDERING GUIDE

QLS-1 Quad isolated output loop splitter/ retransmitter, 85-264 Vac power.

QLS-2 Quad isolated output loop splitter/ retransmitter, 10-48 Vdc or 12-32 Vac power.

3. PRODUCT DESCRIPTION

Model QLS sources up to four (4) independently adjustable 4-20 mA outputs from a single input, which can be 4-20 mA, 1-5V, 0-5V or 0-10V, as selected by jumpers. The outputs can share a common ground. The input and outputs are mutually isolated to +10V / -20V at 600 ohm load by means of active circuitry to accommodate differences in local grounds. If any device in an output loop is removed from the loop or fails, or if a wiring fault occurs, the other loops continue to operate properly. Each loop only drives a single load, avoiding compliance problems.

Model QLS overcomes problems of simply placing loads in series in a single 4-20 mA loop. In such a configuration, the devices in the loop cannot share a common ground, but must be electrically floating, which is often not possible. When any device in a single loop is removed, fails or if a wiring fault occurs, all other devices in the loop loose their 4-20 mA signal. The transmitter voltage compliance limit may be exceeded, since the voltage drops across loads in series are additive. Also, the 4-20 mA signal to each load device cannot be individually adjusted for calibration purposes.

Power for the loop splitter can be 85-264 Vac (Model QLS-1) or low voltage 10-48 Vdc or 12-32 Vac (Model QLS-2). An excitation output is provided on the signal input side to a drive a 2- or 3-wire transmitter at 24 Vdc and up to 30 mA. The output loads have to be passive or sinking. Active or sourcing loads which apply 24 Vdc to an output will burn out the QLS.

Each output loop provides two potentiometers for ±10% fine adjustment of zero and span, a yellow LED lamp to indicate loop continuity, and a current test point across a 10-ohm series resistor, where 200 mV corresponds to 20 mA. This allows a multimeter to be used to measure the loop current without breaking the loop.

4. RECEIVING & UNPACKING

Your QLS loop splitter / retransmitter was carefully tested and inspected prior to shipment. Should the unit be damaged in shipment, notify the freight carrier immediately. Inspect the label on the unit for the type of input power: QLS-1 for 85-264 Vac power, or QLS-2 for 10-48 Vdc or 12-32 Vac power. In the event the unit is not as ordered or is inoperable, return it to the place of purchase for repair or replacement. Please include a description of the problem.

5. SAFETY CONSIDERATIONS

Warning: Use of this unit in a manner other than specified in this manual may impair the protection of the unit and subject the user to a hazard. Do not attempt to operate if the unit shows visible damage.

Cautions:

This unit may be powered from 85-264 Vac with the worldwide voltage power supply (Model QLS-1) or from 12-30 Vac or 10-48 Vdc (Model QLS-2). Verify that you have the proper model for the power to be used. The 85-264 Vac power connector (P1 Pins 1-3) is colored **Green** to differentiate it from other input and output connectors. The 12-30 Vac or 10-48 Vdc power connector is colored **Black**. This unit has no power switch. It will be in operation as soon as power is applied.

The unit's four 4-20 mA analog outputs are **sourcing**. The loads have to be **sinking** (or passive). Active loads designed to power a two-wire sensor with 24 Vdc will burn out the QLS.

To avoid dangers of electrocution and/or short circuit, do not attempt to open the case while the unit is under power

To prevent an electrical or fire hazard, do not expose the unit to excessive moisture. Do not operate the unit in the presence of flammable gases or fumes, as such an environment constitutes an explosion hazard.

Symbols used:

Caution (refer to accompanying documents)

Caution, risk of electric shock

Equipment protected throughout by double insulation or reinforced insulation.

Earth ground

Signal or loop ground

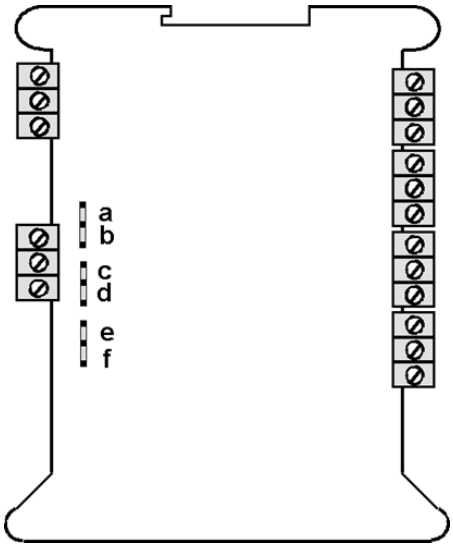
Both direct and alternating current.

Operating environment:

Class II (double insulated) equipment designed for use in Pollution degree 2.

6. JUMPER SETTINGS

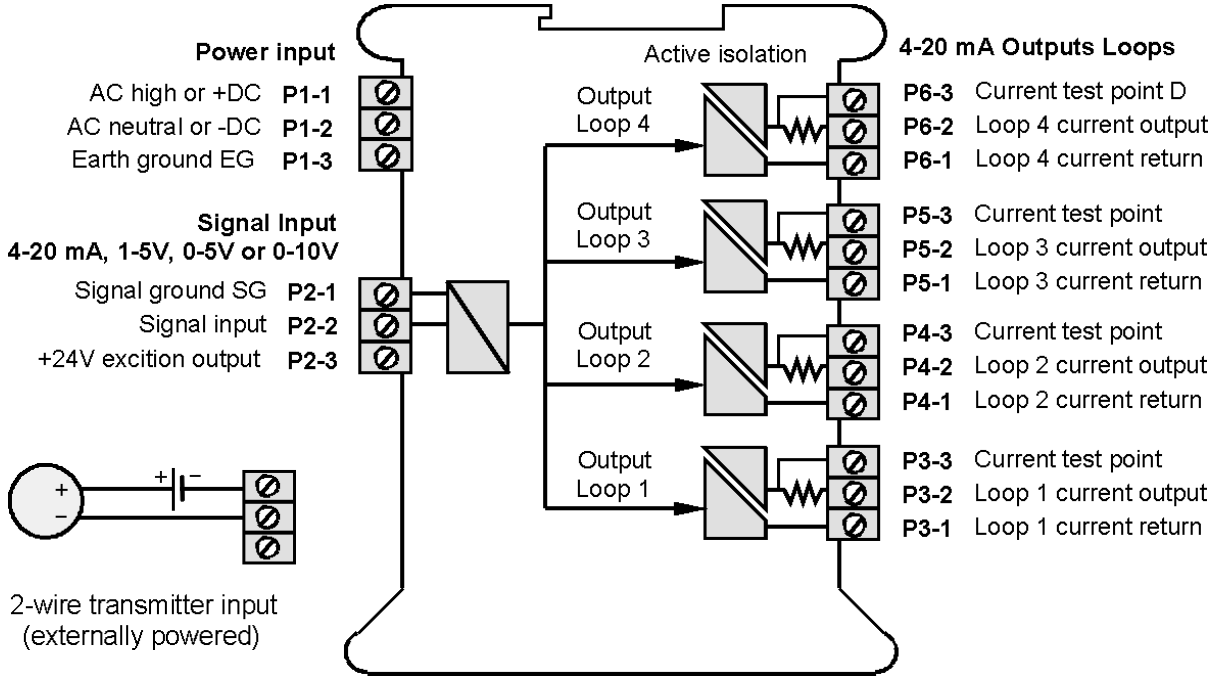
The four outputs are always 4-20 mA process loops. The signal input can be 4-20 mA, 1-5V, 0-5V or 0-10V, as set by jumpers adjacent to the signal input connector on the circuit board. The factory default input setting is 4-20 mA. To change jumpers, remove power, then open the case by removing the screws at the four corners of the case. Store the unused jumper, if any, on an unused pin.

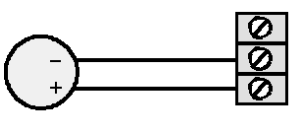


Jumper Positions:

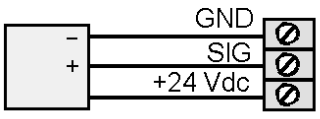
4-20 mA ..... **a + c**
1-5V ..... **d**
0-5V ..... **b + f**
0-10V ..... **a + e**

7. ELECTRICAL CONNECTIONS



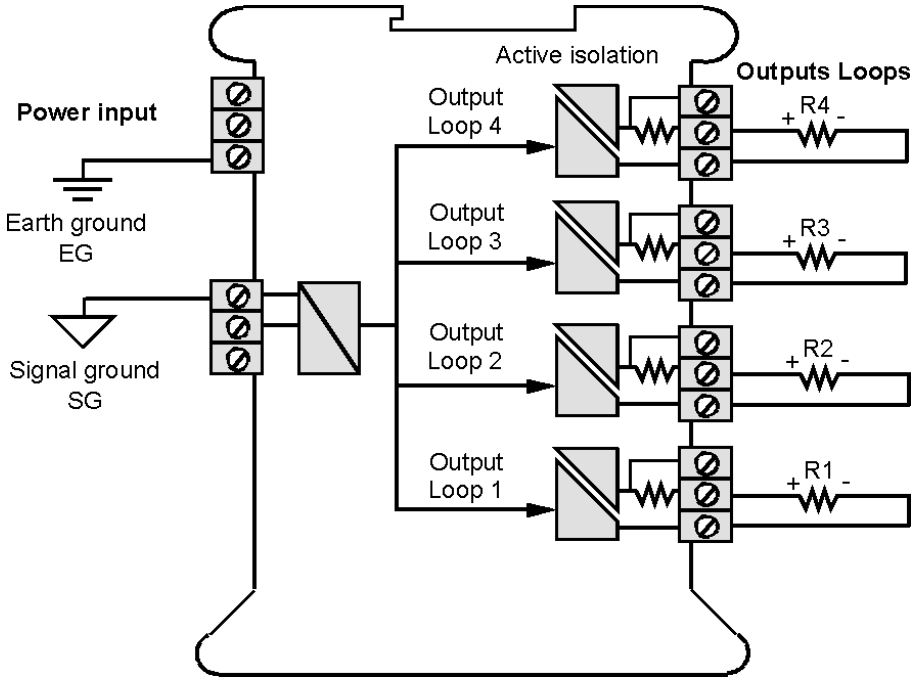


2-wire transmitter input
(loop powered by QLS)

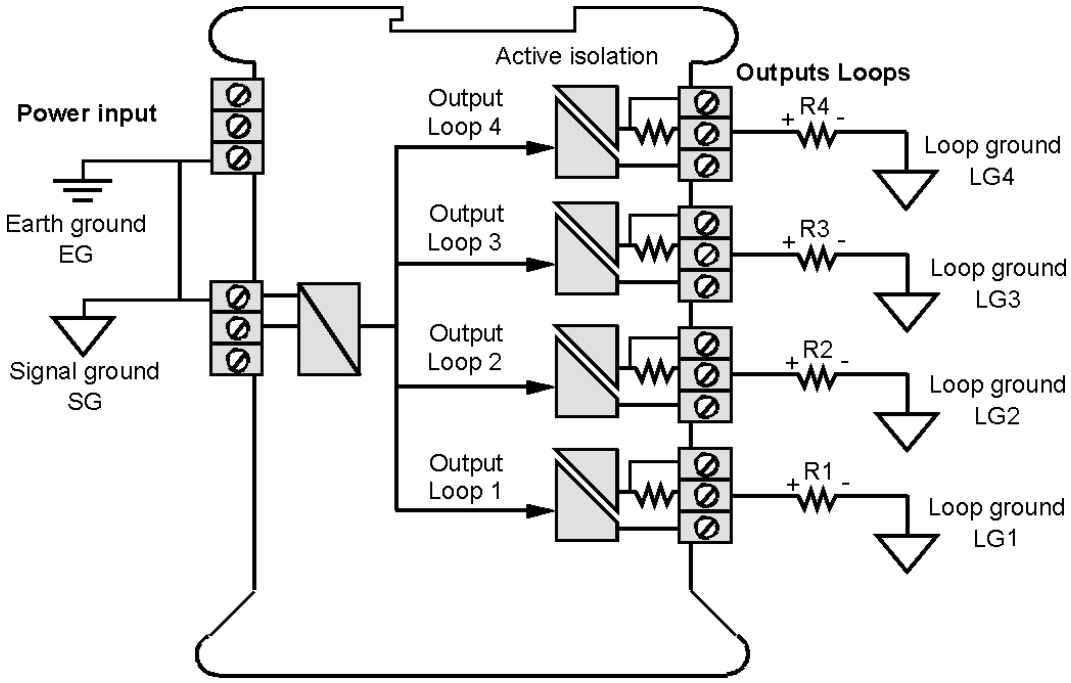


3-wire transmitter input
(24 Vdc power from QLS)

4-wire transmitter input
(externally powered)

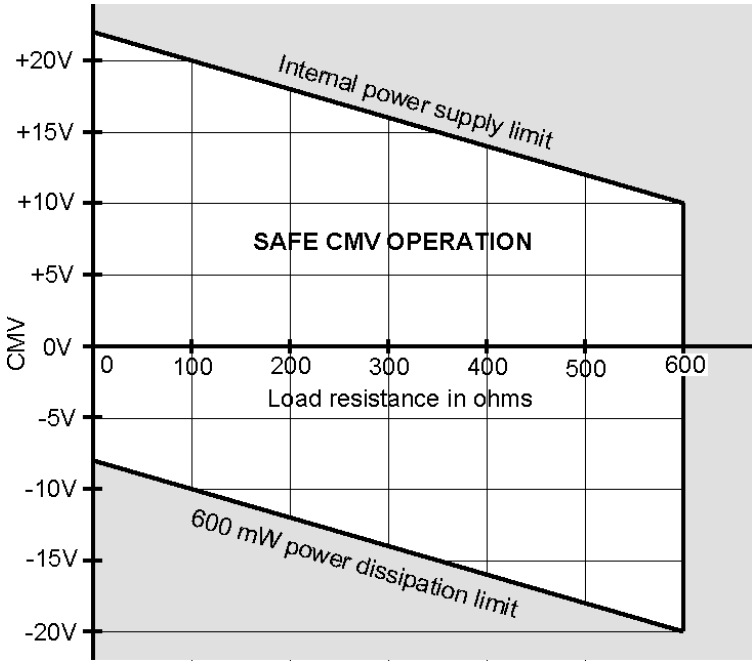


Floating loads: Any output load R that is floating (not connected to a local ground or earth ground) can be connected between current output (Pin 1) and current return (Pin 2). Current return is internally tied to signal ground SG, which can be floating or be connected to earth ground. Loads have to be passive (or sinking).



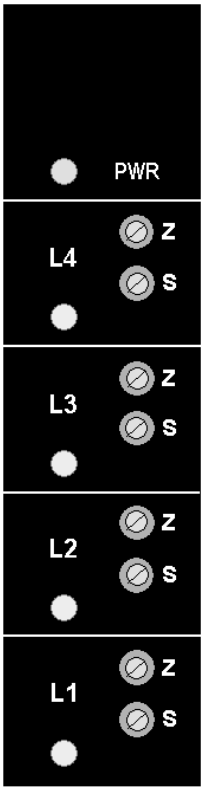
Grounded loads: Any output load R can be connected to a local loop ground LG instead of current return. The loop grounds LG can each be different, but can only differ from signal ground SG by a common mode voltage CMV, which is defined as V_{LG} - V_{SG}. Signal ground SG must be tied to earth ground EG or be within 1 Volt of EG.

If a load R is grounded to a local loop ground LG, the available common mode voltage CMV is limited on the positive side by the unit's internal power supply and on the negative side by the 600 mW power dissipation limit of an output transistor. The diagram to the right shows allowable CMV as a function of output load resistance R. For example, with a 250 ohm load, CMV can range from -13V to +17V. With a 500 ohm load, CMV can range from -18V to +12V. The unit will not work correctly if CMV limits are exceeded or load resistance is greater than 600 ohms. Loads have to be passive (or sinking).



8. SETTING & CALIBRATION

Zero and span of the four output loops (**L1**, **L2**, **L3**, **L4**) are set be means of precision 25-turn potentiometers marked **Z** (for zero) and **S** (for span) on the front panel. The unit is factory jumpered and calibrated so that 4-20 mA in produces 4-20 mA out on all output channels.



To set or calibrate an output channel, apply the low input signal (4 mA, 0V or 1V) which should produce the 4 mA low output. Measure the actual output (e.g., 4.218 mA). Then apply the high input signal (20 mA, 5V or 10V) which should produce the 20 mA high output. Adjust the **S** potentiometer until actual output current equals the just-measured low output plus 16 mA (e.g., 4.218 mA + 16 mA = 20.218 mA). Then reapply the low input which should produce a 4 mA output, and adjust the **Z** potentiometer until the actual output current equals 4.000 mA.

Since electronic components may change as they age, annual recalibration of the output channels is recommended using the **Z** and **S** potentiometers. The input channel does not require calibration.

9. SPECIFICATIONS

Mechanical

Mounting ..... 35 mm DIN rail per EN50 022
Dimensions ..... 22.5 x 103 x 128 mm (0.9" x 4.1" x 5.0") W x H x D
Weight ..... 140 g (5 oz)
Connectors ..... Detachable plug-in screw-clamp connectors
Wire Size ..... 28-12 AWG, 2.5 sq. mm max

Signal Input

Signal Type ..... 4-20 mA, 1-5V, 0-5V, 0-10V (jumper selectable)
Input Resistance ..... 50Ω for 4-20 mA, 500 kΩ for 1-5V & 0-5V, 1 MΩ for 0-10V
Transmitter Excitation ..... 24 Vdc nominal, 30 mA max

Signal Outputs

Number of Outputs 4
Signal Type ..... 4-20 mA sourcing
Zero & Span Adjustment ..... ± 10% for each output with 25-turn potentiometers
Signal Isolation ..... Please see graph on page 6
Voltage Compliance ..... 12V (600 Ω per loop at 20 mA)
Load Regulation ..... ± 0.005% of span from 0 to 600 Ω
Accuracy ..... ± 0.02% max span error at 23°C
Span Tempco ..... ± 10 ppm/°C (0.16 µA/°C) typical, ± 25 ppm/°C (0.4 µA/°C) max
AC Rejection ..... 90 dB from DC to 60 Hz
Response Speed ..... 2 ms risetime, 7 ms settling time to 0.1% of final value
Current Test Point ..... 10Ω ± 0.5% series resistor drops 200 mV at 20 mA
Loop Continuity Indication ..... Yellow LED lamp per loop, brightness increases with current

Power Input

Standard Power (QLS-1) ..... 85-264 Vac or 90-300 Vdc (DC operation not UL approved)
Low Power Option (QLS-2) ..... 10-48 Vdc or 12-32 Vac
Power Frequency ..... DC or 47-63 Hz
Power Isolation ..... 250V rms working, 2.3 kV rms per 1 min test
Power Consumption ..... 3.5 W max, all loops delivering 20 mA
Power On Indication ..... Green LED lamp

Environmental

Operating Temperature ..... -40°C to 70°C
Storage Temperature ..... -40°C to 85°C
Relative Humidity ..... 95% at 40°C, non-condensing
Cooling Required ..... Mount units with ventilation holes at top and bottom. Leave 6 mm (1/4") between units, or force air with a fan.

10. WARRANTY

Laurel Electronics Inc. warrants its products against defects in materials or workmanship for a period of one year from the date of purchase.

In the event of a defect during the warranty period, the defective unit may be returned to the seller, which may be Laurel or a Laurel distributor. The seller may then repair or replace the defective unit at its option. In the event of such a return, freight charges from the buyer shall be paid by the buyer, and freight charges from the seller shall be paid by the seller.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from:

1. Improper installation or miswiring.
2. Improper or inadequate maintenance.
3. Unauthorized modification or misuse.
4. Operation outside the environmental specifications.
5. Mishandling or abuse.

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. Laurel specifically disclaims implied warranties of merchantability and fitness for a particular purpose.

Any electronic product may fail or malfunction over time. To minimize risks associated with reliance on Laurel products, users are expected to provide adequate system-level design and operating safeguards. Laurel's products are intended for general purpose industrial or laboratory use. They are not intended nor certified for use in life-critical medical, nuclear, or aerospace applications, or for use in hazardous locations.

EXCLUSIVE REMEDIES

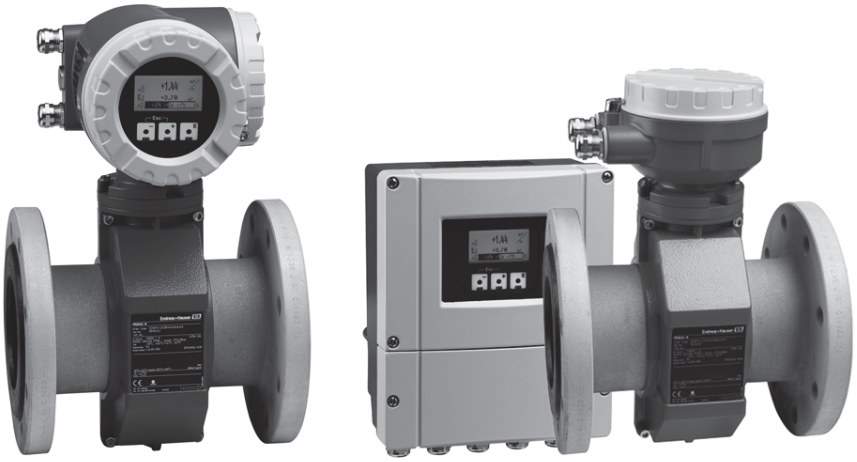
The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall Laurel be liable for direct, indirect, incidental or consequential damages (including loss of profits) whether based on contract, tort, or any other legal theory.

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Proline Promag 50W, 53W

Electromagnetic Flow Measuring System
Flow measurement of liquids in water or wastewater applications



Application

Electromagnetic flowmeter for bidirectional measurement of liquids with a minimum conductivity of ≥ 5 µS/cm:
- Drinking water
- Wastewater
- Sewage sludge

- Flow measurement up to 110000 m³/h (484315 gal/min)
- Fluid temperature up to +80 °C (+176 °F)
- Process pressures up to 40 bar (580 psi)
- Lengths in accordance with DVGW/ISO

Application-specific lining of the measuring pipe from polyurethane or hard rubber with the following drinking water permissions:
- KTW
- WRAS
- NSF
- ACS

Approvals for hazardous area:
- ATEX
- IECEx
- FM
- CSA
- NEPSI

Connection to process control system:
- HART
- PROFIBUS DP/PA
- FOUNDATION Fieldbus
- MODBUS RS485

Your benefits

Promag measuring devices offer you cost-effective flow measurement with a high degree of accuracy for a wide range of process conditions.

The uniform Proline transmitter concept comprises:
- Modular device and operating concept resulting in a higher degree of efficiency
- Software options for batching, electrode cleaning and for measuring pulsating flow
- High degree of reliability and measuring stability
- Uniform operating concept

The tried-and-tested Promag sensors offer:
- No pressure loss
- Not sensitive to vibrations
- Simple installation and commissioning

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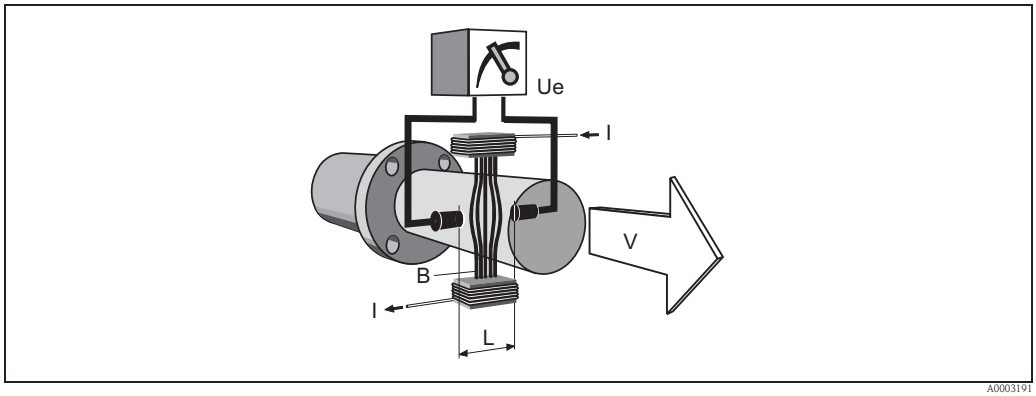
Endress+Hauser
People for Process Automation

Table of contents

Function and system design

Measuring principle

Following *Faraday's law of magnetic induction*, a voltage is induced in a conductor moving through a magnetic field.
In the electromagnetic measuring principle, the flowing medium is the moving conductor.
The voltage induced is proportional to the flow velocity and is supplied to the amplifier by means of two measuring electrodes. The flow volume is calculated by means of the pipe cross-sectional area.
The DC magnetic field is created through a switched direct current of alternating polarity.



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$Ue = B \cdot L \cdot v$
$Q = A \cdot v$

Ue *Induced voltage*
B *Magnetic induction (magnetic field)*
L *Electrode spacing*
v *Flow velocity*
Q *Volume flow*
A *Pipe cross-section*
I *Current strength*

Measuring system

The measuring system consists of a transmitter and a sensor.
Two versions are available:
- Compact version: Transmitter and sensor form a mechanical unit.
- Remote version: Sensor is mounted separate from the transmitter.

Transmitter:
- Promag 50 (user interface with push buttons for operation, two-line display, illuminated)
- Promag 53 ("Touch Control" without opening the housing, four-line display, unilluminated)

Sensor:
- Promag W (DN 25 to 2000 / 1 to 78")

Input

Measured variable

Flow velocity (proportional to induced voltage)

Measuring ranges

Measuring ranges for liquids
Typically v = 0.01 to 10 m/s (0.03 to 33 ft/s) with the specified accuracy

Operable flow range

Over 1000 : 1

Input signal

Status input (auxiliary input)
- U = 3 to 30 V DC, R_i = 5 kΩ, galvanically isolated
- Configurable for: totalizer(s) reset, measured value suppression, error-message reset

Status input (auxiliary input) with PROFIBUS DP and MODBUS RS485
- U = 3 to 30 V DC, R_i = 3 kΩ, galvanically isolated
- Switching level: 3 to 30 V DC, independent of polarity
- Configurable for: totalizer(s) reset, measured value suppression, error-message reset, batching start/stop (optional), batch totalizer reset (optional)

Current input (only Promag 53)
- active/passive selectable, galvanically isolated, full scale value selectable, resolution: 3 µA, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading)
- active: 4 to 20 mA, $R_i \leq 150$ Ω, max. 24 V DC, short-circuit-proof
- passive: 0/4 to 20 mA, $R_i < 150$ Ω, max. 30 V DC

Output

Output signal

Promag 50

Current output
active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s), full scale value selectable, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading), resolution: 0.5 µA
- active: 0/4 to 20 mA, $R_L < 700$ Ω (HART: $R_L \geq 250$ Ω)
- passive: 4 to 20 mA, operating voltage V_S: 18 to 30 V DC, $R_i \geq 150$ Ω

Pulse/frequency output
passive, open collector, 30 V DC, 250 mA, galvanically isolated
- Frequency output: full scale frequency 2 to 1000 Hz (f_{max} = 1250 Hz), on/off ratio 1:1, pulse width max. 10s
- Pulse output: pulse value and pulse polarity selectable, max. pulse width configurable (0.5 to 2000 ms)

PROFIBUS DP interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- Profil version 3.0
- Data transmission rate: 9,6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Function blocks: 1 × analog Input, 1 × totalizer
- Output data: volume flow, totalizer
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

PROFIBUS PA interface
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- Profil version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Function blocks: 1 × analog input, 2 × totalizer
- Output data: volume flow, totalizer
- Input data: positive zero return (ON/OFF), control totalizer, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

Promag 53

Current output
active/passive selectable, galvanically isolated, time constant selectable (0.01 to 100 s),
full scale value selectable, temperature coefficient: typ. 0.005% o.r./°C (o.r. = of reading), resolution: 0.5 µA
- active: 0/4 to 20 mA, R_L < 700 Ω (HART: $R_L \geq 250$ Ω)
- passive: 4 to 20 mA, operating voltage V_S: 18 to 30 V DC, $R_i \geq 150$ Ω

Pulse/frequency output
active/passive selectable, galvanically isolated (Ex i version: only passive)
- active: 24 V DC, 25 mA (max. 250 mA during 20 ms), R_L > 100 Ω
- passive: open collector, 30 V DC, 250 mA
- Frequency output: full scale frequency 2 to 10000 Hz (f_{max} = 12500 Hz), EEx-ia: 2 to 5000 Hz; on/off ratio 1:1, pulse width max. 10 s
- Pulse output: pulse value and pulse polarity selectable, max. pulse width configurable (0.05 to 2000 ms)

PROFIBUS DP interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- Profil version 3.0
- Data transmission rate: 9,6 kBaud to 12 MBaud
- Automatic data transmission rate recognition
- Function blocks: 2 × analog Input, 3 × totalizer
- Output data: volume flow, calculated mass flow, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device
- Available output combination → 📄 8

PROFIBUS PA interface
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- Profil version 3.0
- Current consumption: 11 mA
- Permissible supply voltage: 9 to 32 V
- Bus connection with integrated reverse polarity protection
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Function blocks: 2 × analog input, 3 × totalizer
- Output data: volume flow, calculated mass flow, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), totalizer control, value for local display
- Cyclic data transmission compatible with previous model Promag 33
- Bus address adjustable via miniature switches or local display (optional) at the measuring device

MODBUS RS485 interface
- Transmission technology (Physical Layer): RS485 in accordance with ANSI/TIA/EIA-485-A: 1998, galvanically isolated
- MODBUS device type: Slave
- Adress range: 1 to 247
- Bus address adjustable via miniature switches or local display (optional) at the measuring device
- Supported MODBUS function codes: 03, 04, 06, 08, 16, 23
- Broadcast: supported with the function codes 06, 16, 23
- Übertragungsmodus: RTU oder ASCII
- Supported baudrate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Baud
- Response time:
  - Direct data access = typically 25 to 50 ms
  - Auto-scan buffer (data range) = typically 3 to 5 ms
- Available output combination → 📄 8

FOUNDATION Fieldbus interface
- FOUNDATION Fieldbus H1
- Transmission technology (Physical Layer): IEC 61158-2 (MBP), galvanically isolated
- ITK version 5.01
- Current consumption: 12 mA
- Error current FDE (Fault Disconnection Electronic): 0 mA
- Bus connection with integrated reverse polarity protection
- Function blocks:
  - 5 × Analog Input (execution time: 18 ms each)
  - 1 × PID (25 ms)
  - 1 × Digital Output (18 ms)
  - 1 × Signal Characterizer (20 ms)
  - 1 × Input Selector (20 ms)
  - 1 × Arithmetic (20 ms)
  - 1 × Integrator (18 ms)
- Output data: volume flow, calculated mass flow, temperature, totalizer 1 to 3
- Input data: positive zero return (ON/OFF), reset totalizer
- Link Master (LM) functionality is supported

Signal on alarm
- Current output → failure response selectable (e.g. in accordance with NAMUR recommendation NE 43)
- Pulse/frequency output → failure response selectable
- Status output (Promag 50) → non-conductive by fault or power supply failure
- Relay output (Promag 53) → de-energized by fault or power supply failure

Load

see "Output signal"

Low flow cutoff

Switch points for low flow cutoff are selectable.

Galvanic isolation

All circuits for inputs, outputs and power supply are galvanically isolated from each other.

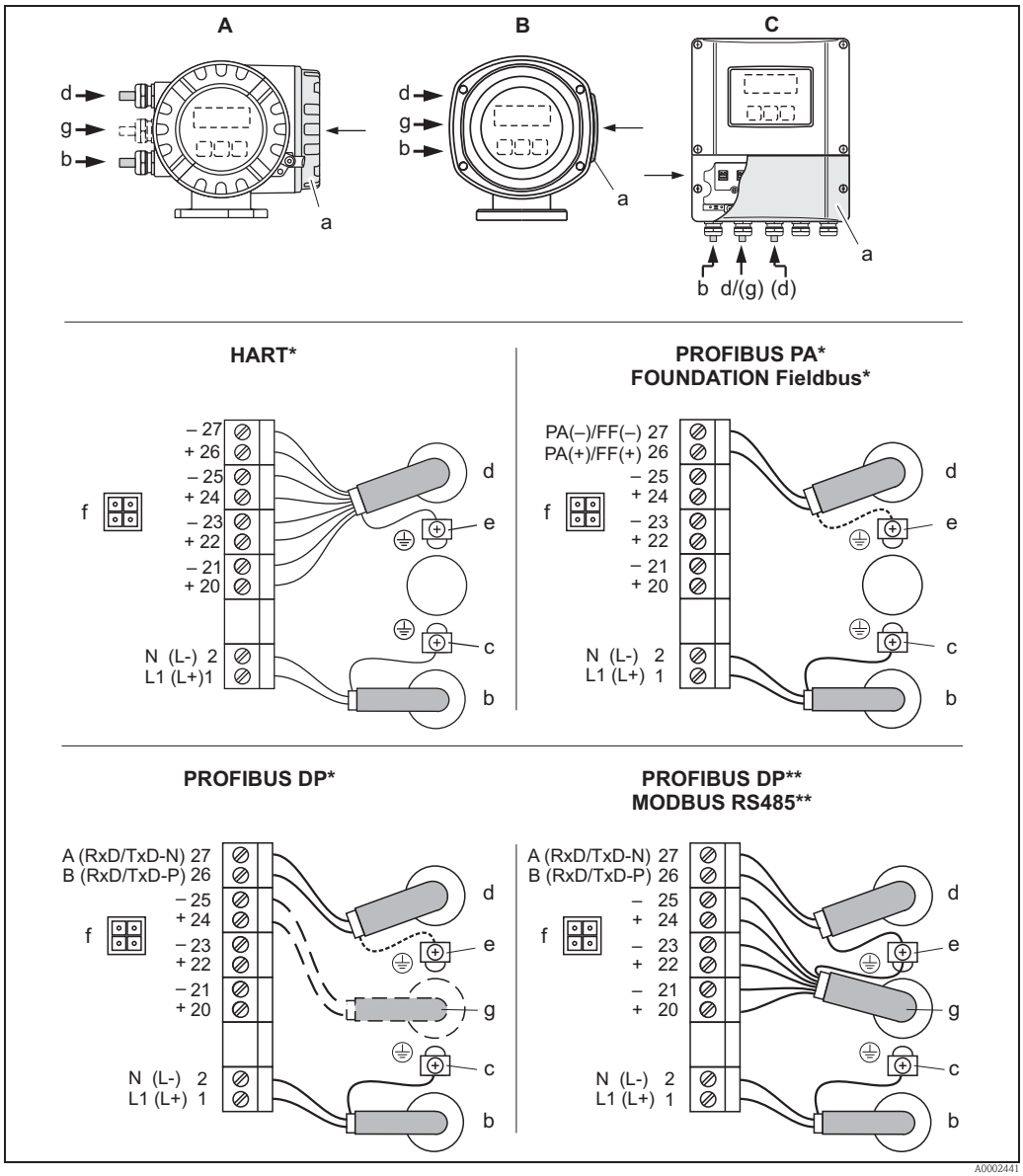
Switching output

Status output (Promag 50, Promag 53)
Open collector, max. 30 V DC / 250 mA, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values.

Relay outputs (Promag 53)
Normally closed (NC or break) or normally open (NO or make) contacts available
(default: relay 1 = NO, relay 2 = NC), max. 30 V / 0,5 A AC ; 60 V / 0,1 A DC, galvanically isolated.
Configurable for: error messages, Empty Pipe Detection (EPD), flow direction, limit values, batching contacts.

Power supply

Electrical connection, measuring unit



Connecting the transmitter, cable cross-section max. 2.5 mm² (14 AWG)

A View A (field housing)
B View B (stainless steel field housing)
C View C (wall-mount housing)

**)* fixed communication boards
***)* flexible communication boards
a Connection compartment cover
b Cable for power supply: 85 to 260 V AC / 20 to 55 V AC / 16 to 62 V DC
- Terminal No. 1: L1 for AC, L+ for DC
- Terminal No. 2: N for AC, L– for DC

c Ground terminal for protective conductor
d Signal cable: see "Electrical connection, terminal assignment" → 🖹 8
Fieldbus cable:
- Terminal No. 26: DP (B) / PA + / FF + / MODBUS RS485 (B) / (PA, FF: with polarity protection)
- Terminal No. 27: DP (A) / PA – / FF – / MODBUS RS485 (A) / (PA, FF: with polarity protection)

e Ground terminal for signal cable shield / Fieldbus cable / RS485 line
f Service adapter for connecting service interface FXA193 (Fieldcheck, FieldCare)
g Signal cable: see "Electrical connection, terminal assignment" → 🖹 8
Cable for external termination (only for PROFIBUS DP with fixed assignment communication board):
- Terminal No. 24: +5 V
- Terminal No. 25: DGND

Electrical connection, terminal assignment

Terminal assignment, Promag 50

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
50***-**********W	–	–	–	Current output HART
50***-**********A	–	–	Frequency output	Current output HART
50***-**********D	Status input	Status output	Frequency output	Current output HART
50***-**********H	–	–	–	PROFIBUS PA
50***-**********J	–	–	+5 V (external termination)	PROFIBUS DP
50***-**********S	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART
50***-**********T	–	–	Frequency output, Ex i, passive	Current output, Ex i, passive, HART

Ground terminal → 🖹 7

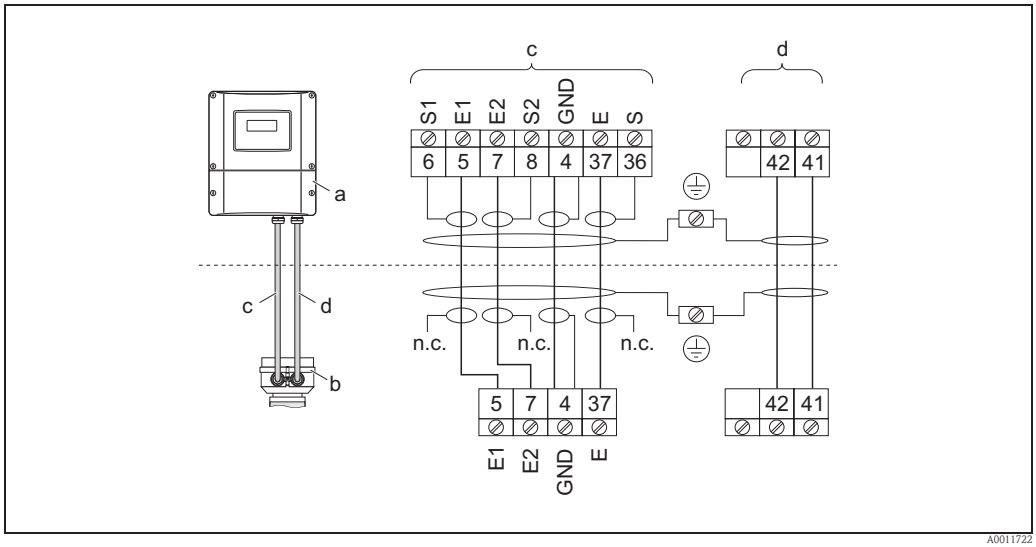
Terminal assignment, Promag 53

The inputs and outputs on the communication board can be either permanently assigned or variable, depending on the version ordered (see table). Replacements for modules which are defective or which have to be replaced can be ordered as accessories.

Order variant	Terminal No. (inputs/outputs)			
	20 (+) / 21 (–)	22 (+) / 23 (–)	24 (+) / 25 (–)	26 (+) / 27 (–)
Fixed communication boards (fixed assignment)				
53***-**********A	–	–	Frequency output	Current output HART
53***-**********B	Relay output 2	Relay output 1	Frequency output	Current output HART
53***-**********F	–	–	–	PROFIBUS PA, Ex i
53***-**********G	–	–	–	FOUNDATION Fieldbus, Ex i
53***-**********H	–	–	–	PROFIBUS PA
53***-**********J	–	–	–	PROFIBUS DP
53***-**********K	–	–	–	FOUNDATION Fieldbus
53***-**********Q	–	–	Status input	MODBUS RS485
53***-**********S	–	–	Frequency output, Ex i	Current output, Ex i, passive, HART
53***-**********T	–	–	Frequency output, Ex i	Current output, Ex i, passive, HART
Flexible communication boards				
53***-**********C	Relay output 2	Relay output 1	Frequency output	Current output HART
53***-**********D	Status input	Relay output	Frequency output	Current output HART
53***-**********L	Status input	Relay output 2	Relay output 1	Current output HART
53***-**********M	Status input	Frequency output	Frequency output	Current output HART
53***-**********N	Current output	Frequency output	Status input	MODBUS RS485
53***-**********P	Current output	Frequency output	Status input	PROFIBUS DP
53***-**********V	Relay output 2	Relay output 1	Status input	PROFIBUS DP
53***-**********2	Relay output	Current output	Frequency output	Current output HART
53***-**********4	Current input	Relay output	Frequency output	Current output HART
53***-**********7	Relay output 2	Relay output 1	Status input	MODBUS RS485

Ground terminal → 🖹 7

Electrical connection, remote version



Connecting the remote version

a Wall-mount housing connection compartment
b Sensor connection housing cover
c Signal cable
d Coil current cable
n.c. Not connected, insulated cable shields
Terminal no. and cable colors: 6/5 = brown; 7/8 = white; 4 = green; 36/37 = yellow

Supply voltage (power supply)

- 85 to 260 V AC, 45 to 65 Hz
- 20 to 55 V AC, 45 to 65 Hz
- 16 to 62 V DC

PROFIBUS PA and FOUNDATION Fieldbus
- Non-Ex: 9 to 32 V DC
- Ex i: 9 to 24 V DC
- Ex d: 9 to 32 V DC

Cable entry

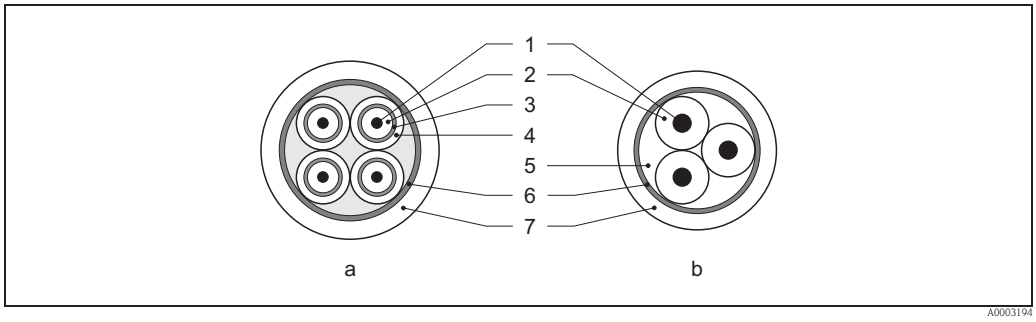
Power supply and signal cables (inputs/ outputs):
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Sensor cable entry for armoured cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entries, ½" NPT, G ½"

Connecting cable for remote version:
- Cable entry M20 × 1.5 (8 to 12 mm / 0.31 to 0.47")
- Sensor cable entry for armoured cables M20 × 1.5 (9.5 to 16 mm / 0.37 to 0.63")
- Thread for cable entries, ½" NPT, G ½"

Remote version cable specifications

Coil cable
- 2 × 0.75 mm^2 (18 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28")
- Conductor resistance: ≤ 37 Ω/km (≤ 0.011 Ω/ft)
- Capacitance core/core, shield grounded: ≤ 120 pF/m (≤ 37 pF/ft)
- Operating temperature: –20 to +80 °C (–68 to +176 °F)
- Cable cross-section: max. 2.5 mm^2 (14 AWG)
- Test voltage for cable insulation: ≤ 1433 AC r.m.s. 50/60 Hz or ≥ 2026 V DC

Signal cable
- 3 × 0.38 mm^2 (20 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28") and individual shielded cores
- With empty pipe detection (EPD): 4 × 0.38 mm^2 (20 AWG) PVC cable with common, braided copper shield (∅ ~ 7 mm / 0.28") and individual shielded cores
- Conductor resistance: ≤ 50 Ω/km (≤ 0.015 Ω/ft)
- Capacitance core/shield: ≤ 420 pF/m (≤ 128 pF/ft)
- Operating temperature: –20 to +80 °C (–68 to +176 °F)
- Cable cross-section: max. 2.5 mm^2 (14 AWG)



a *Signal cable*
b *Coil current cable*

1 *Core*
2 *Core insulation*
3 *Core shield*
4 *Core jacket*
5 *Core reinforcement*
6 *Cable shield*
7 *Outer jacket*

Operation in zones of severe electrical interference
The measuring device complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of IEC/EN 61326 and NAMUR recommendation NE 21.

Caution!
Grounding is by means of the ground terminals provided for the purpose inside the connection housing. Ensure that the stripped and twisted lengths of cable shield to the ground terminal are as short as possible.

Power consumption

- AC: < 15 VA (incl. sensor)
- DC: < 15 W (incl. sensor)

Switch-on current:
- Max. 3 A (< 5 ms) for 260 V AC
- Max. 13.5 A (< 50 ms) for 24 V DC

Power supply failure

Lasting min. ½ cycle frequency: EEPROM saves measuring system data
- EEPROM or T-DAT (Promag 53 only) retain the measuring system data in the event of a power supply failure
- S-DAT: exchangeable data storage chip which stores the data of the sensor (nominal diameter, serial number, calibration factor, zero point etc.)

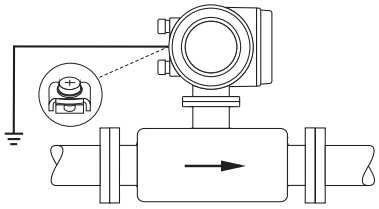
Potential equalization

Warning!
The measuring system must be included in the potential equalization.

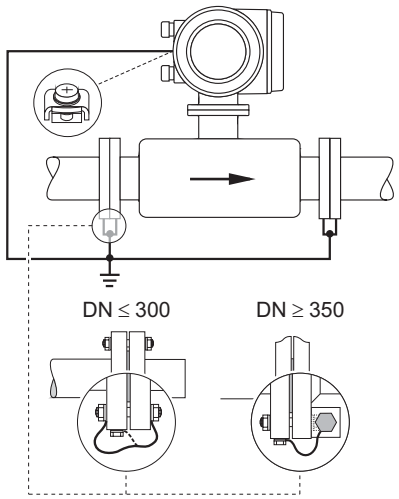
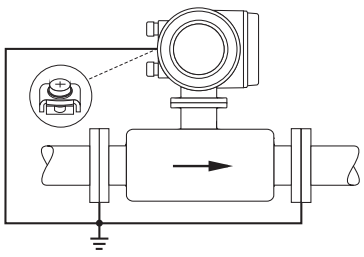
Perfect measurement is only ensured when the fluid and the sensor have the same electrical potential. This is ensured by the reference electrode integrated in the sensor as standard.

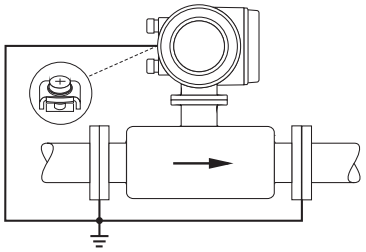
The following should also be taken into consideration for potential equalization:
- Internal grounding concepts in the company
- Operating conditions, such as the material/ grounding of the pipes (see table)

Standard situation

Operating conditions	Potential equalization
When using the measuring device in a: ■ Metal, grounded pipe Potential equalization takes place via the ground terminal of the transmitter. Note! When installing in metal pipes, we recommend you connect the ground terminal of the transmitter housing with the piping.	 A0011892 *Via the ground terminal of the transmitter*

Special situations

Operating conditions	Potential equalization
When using the measuring device in a: ■ Metal pipe that is not grounded This connection method also applies in situations where: ■ Customary potential equalization cannot be ensured. ■ Excessively high equalizing currents can be expected. Both sensor flanges are connected to the pipe flange by means of a ground cable (copper wire, at least 6 mm² / 0.0093 in²) and grounded. Connect the transmitter or sensor connection housing, as applicable, to ground potential by means of the ground terminal provided for the purpose. ■ DN ≤ 300 (12"): the ground cable is mounted directly on the conductive flange coating with the flange screws. ■ DN ≥ 350 (14"): the ground cable is mounted directly on the transportation metal support. Note! The ground cable for flange-to-flange connections can be ordered separately as an accessory from Endress+Hauser.	 A0011893 *Via the ground terminal of the transmitter and the flanges of the pipe*
When using the measuring device in a: ■ Plastic pipe ■ Pipe with insulating lining This connection method also applies in situations where: ■ Customary potential equalization cannot be ensured. ■ Excessively high equalizing currents can be expected. Potential equalization takes place using additional ground disks, which are connected to the ground terminal via a ground cable (copper wire, at least 6 mm² / 0.0093 in²). When installing the ground disks, please comply with the enclosed Installation Instructions.	 A0011895 *Via the ground terminal of the transmitter and the optionally available ground disks*

Operating conditions	Potential equalization
When using the measuring device in a: ■ Pipe with a cathodic protection unit The device is installed potential-free in the pipe. Only the two flanges of the pipe are connected with a ground cable (copper wire, at least 6 mm² / 0.0093 in²). Here, the ground cable is mounted directly on the conductive flange coating with flange screws. Note the following when installing: ■ The applicable regulations regarding potential-free installation must be observed. ■ There should be **no** electrically conductive connection between the pipe and the device. ■ The mounting material must withstand the applicable torques.	 A0011896 *Potential equalization and cathodic protection* *1 Power supply isolation transformer* *2 Electrically isolated*

Performance characteristics

Reference operating conditions

As per DIN EN 29104 and VDI/VDE 2641:
- Fluid temperature: +28 °C ± 2 K (+82 °F ± 2 K)
- Ambient temperature: +22 °C ±2 K (+72 °F ± 2 K)
- Warm-up period: 30 minutes

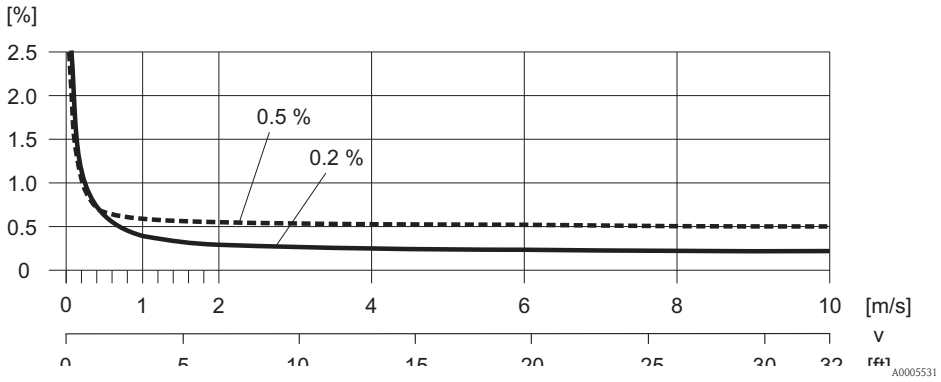
Installation conditions:
- Inlet run > 10 × DN
- Outlet run > 5 × DN
- Sensor and transmitter grounded.
- The sensor is centered in the pipe.

Maximum measured error

Promag 50:
- Current output: also typically ± 5 µA
- Pulse output: ±0.5% o.r. ± 1 mm/s (±0.5% o.r. ± 0.04 in/s)
  optional: ±0.2% o.r. ± 2 mm/s (±0.2% o.r. ± 0.08 in/s) (o.r. = of reading)

Promag 53:
- Current output: also typically ± 5 µA
- Pulse output: ±0.2% o.r. ± 2 mm/s (±0.2% o.r. ± 0.08 in/s) (o.r. = of reading)

Fluctuations in the supply voltage do not have any effect within the specified range.



Max. measured error in % of reading

Repeatability

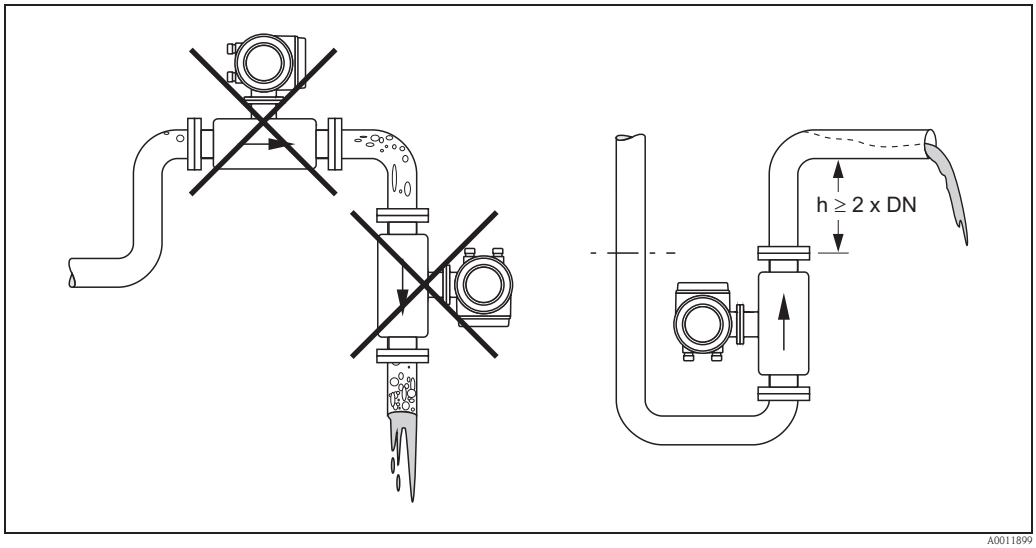
Max. ±0.1% o.r. ± 0.5 mm/s (±0.1% o.r. ± 0.02 in/s) (o.r. = of reading)

Operating conditions: Installations

Installation instructions

Mounting location

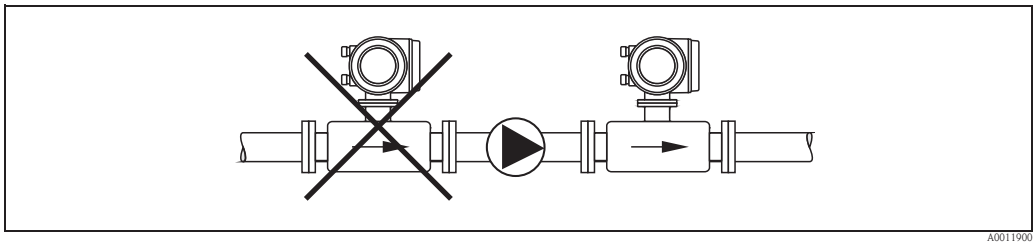
Entrained air or gas bubble formation in the measuring tube can result in an increase in measuring errors.
Avoid the following installation locations in the pipe:
- Highest point of a pipeline. Risk of air accumulating!
- Directly upstream from a free pipe outlet in a vertical pipeline.



Mounting location

Installation of pumps

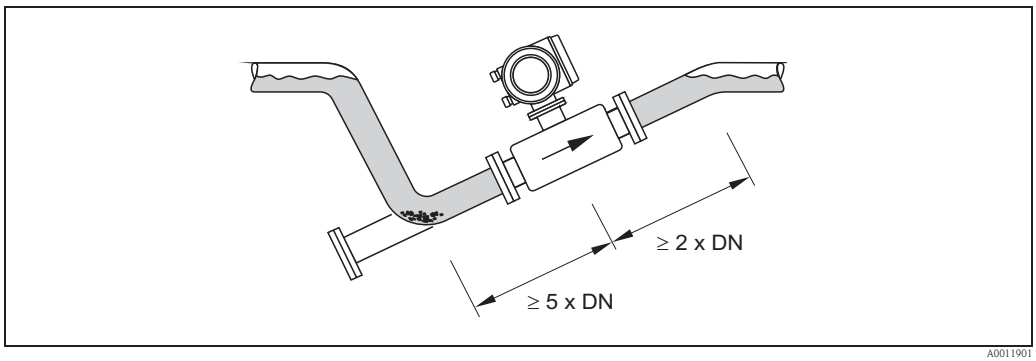
Sensors may not be installed on the pump suction side. This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. Information on the pressure tightness of the measuring tube lining → 21, Section "Pressure tightness".
Pulsation dampers may be needed when using piston pumps, piston diaphragm pumps or hose pumps. Information on the shock and vibration resistance of the measuring system → 20, Section "Shock and vibration resistance".



Installation of pumps

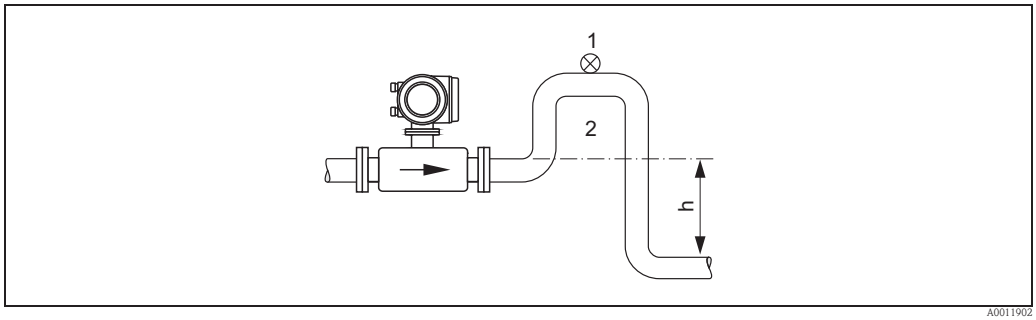
Partially filled pipes
Partially filled pipes with gradients necessitate a drain-type configuration.
The empty pipe detection function (EPD) provides additional security in detecting empty or partially filled pipes.

Caution!
Risk of solids accumulating. Do not install the sensor at the lowest point in the drain. It is advisable to install a cleaning valve.



Installation with partially filled pipes

Down pipes
Install a siphon or a vent valve downstream of the sensor in down pipes h ≥ 5 m (16.4 ft). This precaution is to avoid low pressure and the consequent risk of damage to the lining of the measuring tube. This measure also prevents the liquid current stopping in the pipe which could cause air locks. Information on the pressure tightness of the measuring tube lining → 📄 21, Section "Pressure tightness".



Installation measures for vertical pipes

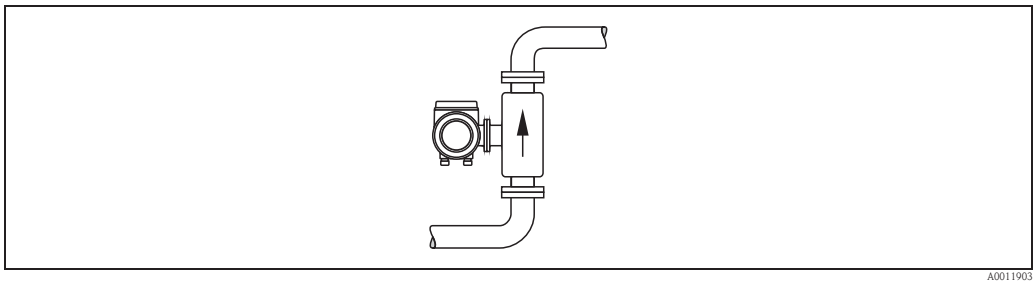
1 Vent valve
2 Pipe siphon
h Length of the down pipe

Orientation

An optimum orientation helps avoid gas and air accumulations and deposits in the measuring tube. However, the measuring device also offers the additional function of empty pipe detection (EPD) for detecting partially filled measuring tubes or if outgassing fluids or fluctuating operating pressures are present.

Vertical orientation

This is the ideal orientation for self-emptying piping systems and for use in conjunction with empty pipe detection.



A0011903

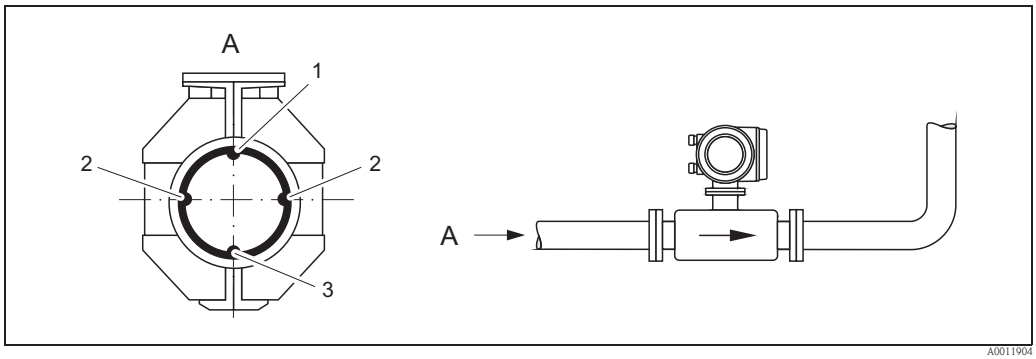
Vertical orientation

Horizontal orientation

The measuring electrode axis should be horizontal. This prevents brief insulation of the two measuring electrodes by entrained air bubbles.

Caution!

Empty pipe detection only works correctly with horizontal orientation if the transmitter housing is facing upwards. Otherwise there is no guarantee that empty pipe detection will respond if the measuring tube is only partially filled or empty.



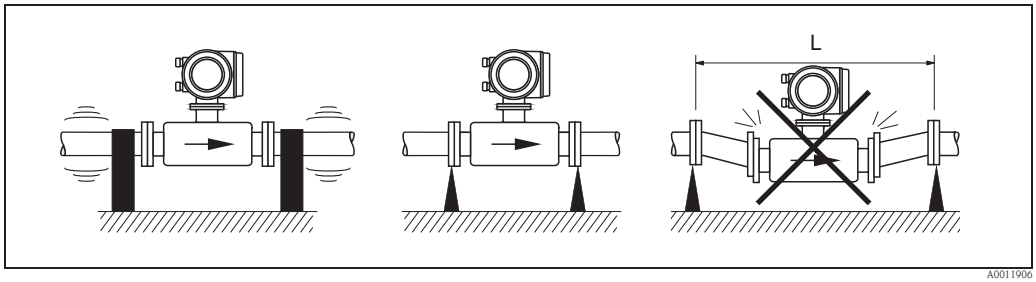
A0011904

Horizontal orientation

1 EPD electrode for empty pipe detection
2 Measuring electrodes for signal detection
3 Reference electrode for potential equalization

Vibrations
Secure the piping and the sensor if vibration is severe.

Caution!
If vibrations are too severe, we recommend the sensor and transmitter be mounted separately. Information on the permitted shock and vibration resistance → 20, Section "Shock and vibration resistance".

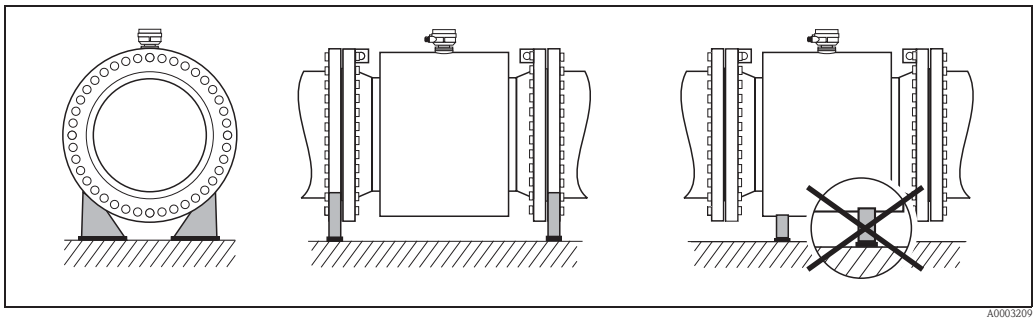


Measures to prevent vibration of the measuring device

L > 10 m (33 ft)

Foundations, supports
If the nominal diameter is DN ≥ 350, mount the transmitter on a foundation of adequate load-bearing strength.

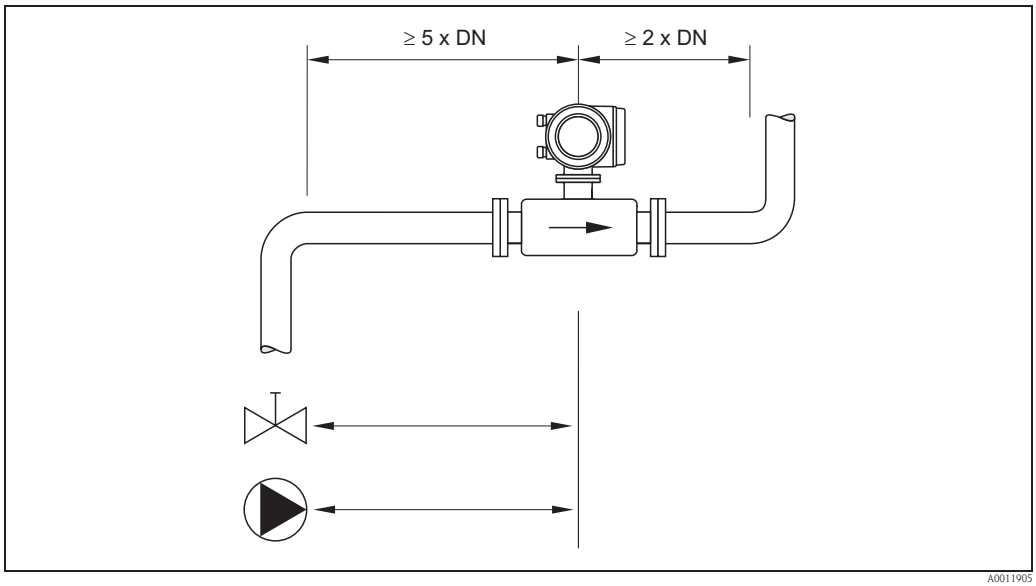
Caution!
Do not allow the casing to take the weight of the sensor. This would buckle the casing and damage the internal magnetic coils.



Inlet and outlet run

If possible, install the sensor well clear of assemblies such as valves, T-pieces, elbows etc.

Note the following inlet and outlet runs to comply with measuring accuracy specifications:
- Inlet run: ≥ 5 × DN
- Outlet run: ≥ 2 × DN



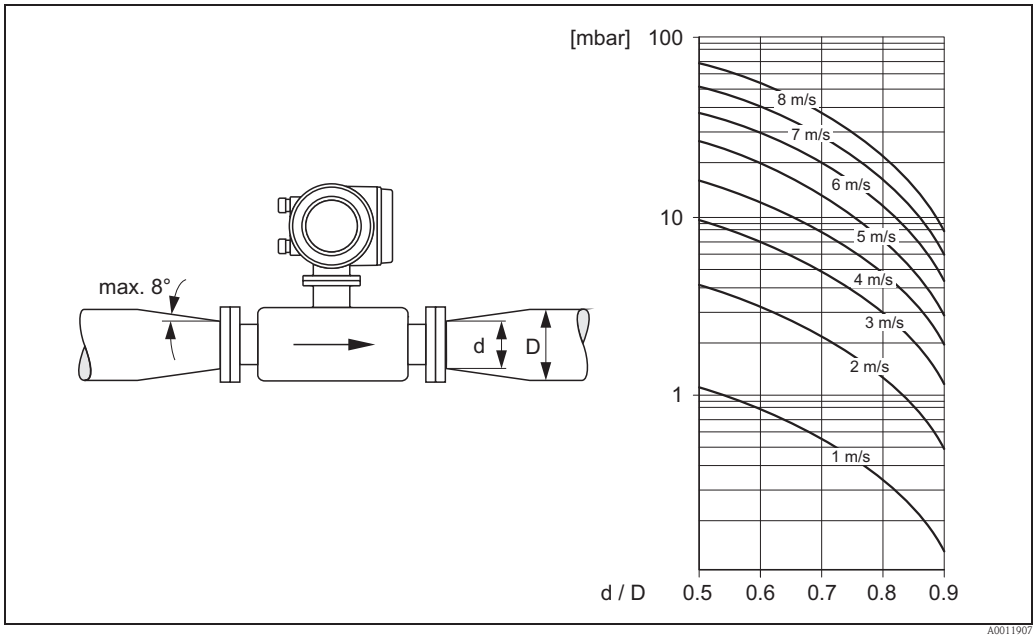
Inlet and outlet run

Adapters

Suitable adapters to DIN EN 545 (double-flange reducers) can be used to install the sensor in larger-diameter pipes. The resultant increase in the rate of flow improves measuring accuracy with very slow-moving fluids. The nomogram shown here can be used to calculate the pressure loss caused by reducers and expanders.

Note!
The nomogram only applies to liquids of viscosity similar to water.

1. Calculate the ratio of the diameters d/D.
2. From the nomogram read off the pressure loss as a function of flow velocity (downstream from the reduction) and the d/D ratio.

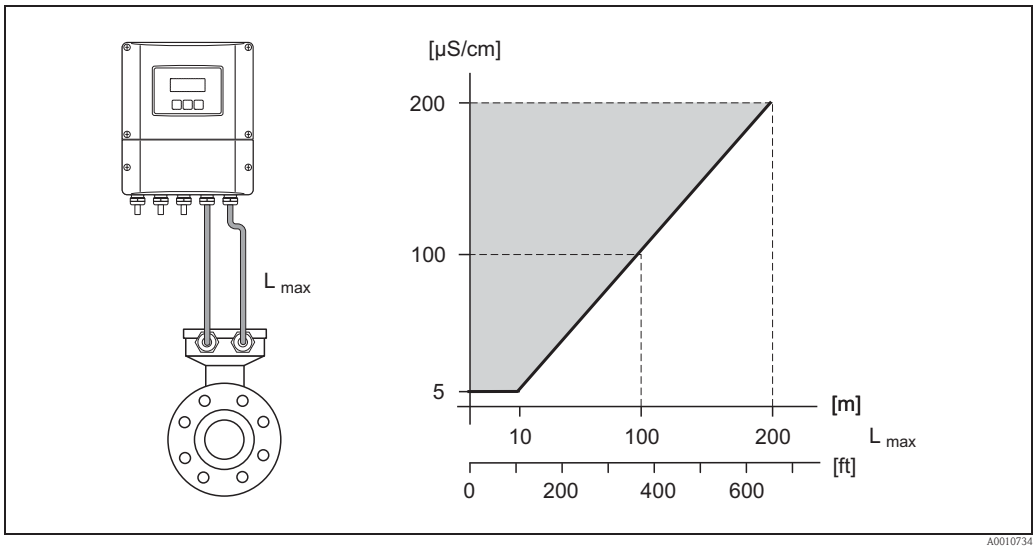


Pressure loss due to adapters

Length of connecting cable

When mounting the remote version, please note the following to achieve correct measuring results:

- Fix cable run or lay in armored conduit. Cable movements can falsify the measuring signal especially in the case of low fluid conductivities.
- Route the cable well clear of electrical machines and switching elements.
- If necessary, ensure potential equalization between sensor and transmitter.
- The permitted cable length L_{max} is determined by the fluid conductivity. A minimum conductivity of 20 µS/cm is required for measuring demineralized water.
- When the empty pipe detection function is switched on (EPD), the maximum connecting cable length is 10 m (33 ft).



Permitted length of connecting cable for remote version
Area marked in gray = permitted range; L_{max} = length of connecting cable in [m] ([ft]); fluid conductivity in [µS/cm]

Operating conditions: Environment

Ambient temperature range

Transmitter
- Standard: –20 to +60 °C (–4 to +140 °F)
- Optional: –40 to +60 °C (–40 to +140 °F)

Note!
At ambient temperatures below –20 °C (–4 °F)the readability of the display may be impaired.

Sensor
- Flange material carbon steel: –10 to +60 °C (14 to +140 °F)
- Flange material stainless steel: –40 to +60 °C (–40 to +140 °F)

Caution!
The permitted temperature range of the measuring tube lining may not be undershot or overshot
→ 21, Section "Medium temperature range".

Please note the following points:
- Install the device in a shady location. Avoid direct sunlight, particularly in warm climatic regions.
- The transmitter must be mounted separate from the sensor if both the ambient and fluid temperatures are high.

Storage temperature

The storage temperature corresponds to the operating temperature range of the measuring transmitter and the appropriate measuring sensors.

Caution!
- The measuring device must be protected against direct sunlight during storage in order to avoid unacceptably high surface temperatures.
- A storage location must be selected where moisture does not collect in the measuring device. This will help prevent fungus and bacteria infestation which can damage the liner.
- Do not remove the protective plates or caps on the process connections until the device is ready to install.

Degree of protection
- Standard: IP 67 (NEMA 4X) for transmitter and sensor.
- Optional: IP 68 (NEMA 6P) for sensor for remote version.
- For information regarding applications where the device is buried directly in the soil or is installed in a flooded wastewater basin please contact your local Endress+Hauser Sales Center.

Shock and vibration resistance

Acceleration up to 2 g following IEC 600 68-2-6

Electromagnetic compatibility (EMC)
- As per IEC/EN 61326 and NAMUR recommendation NE 21.

Operating conditions: Process

Medium temperature range

The permitted temperature depends on the lining of the measuring tube:
- Polyurethane: –20 to +50 °C (–4 to +122 °F) (DN 25 to 1200 / 1 to 48")
- Hard rubber: ±0 to +80 °C (+32 to +176 °F) (DN 50 to 2000 / 2 to 78")

Conductivity

The minimum conductivity is:
- ≥ 5 µS/cm for fluids generally
- ≥ 20 µS/cm for demineralized water

Note!
In the remote version, the necessary minimum conductivity also depends on the cable length (→ 19, Section "Length of connecting cable").

Medium pressure range (nominal pressure)

- EN 1092-1 (DIN 2501)
  - PN 6 (DN 350 to 2000 / 14 to 78")
  - PN 10 (DN 200 to 2000 / 8 to 78")
  - PN 16 (DN 65 to 2000 / 3 to 78")
  - PN 25 (DN 200 to 1000 / 8 to 40")
  - PN 40 (DN 25 to 150 / 1 to 6")
- ANSI B 16.5
  - Class 150 (DN 1 to 24")
  - Class 300 (DN 1 to 6")
- AWWA
  - Class D (DN 28 to 78")
- JIS B2220
  - 10 K (DN 50 to 300 / 2 to 12")
  - 20 K (DN 25 to 300 / 1 to 12")
- AS 2129
  - Table E (DN 80, 100, 150 to 400, 500, 600 / 3", 4", 6 to 16", 20", 24")
- AS 4087
  - PN 16 (DN 80, 100, 150 to 400, 500, 600 / 3", 4", 6 to 16", 20", 24")

Pressure tightness

Measuring tube lining: Polyurethane

Nominal diameter		Limit values for abs. pressure [mbar] ([psi]) at fluid temperatures:			
		25 °C (77 °F)		50 °C (122 °F)	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]
25 to 1200	1 to 48"	0	0	0	0

Measuring tube lining: Hard rubber

Nominal diameter		Limit values for abs. pressure [mbar] ([psi]) at fluid temperatures:					
		25 °C (77 °F)		50 °C (122 °F)		80 °C (176 °F)	
[mm]	[inch]	[mbar]	[psi]	[mbar]	[psi]	[mbar]	[psi]
50 to 2000	2 to 78"	0	0	0	0	0	0

Limiting flow

The diameter of the pipe and the flow rate determine the nominal diameter of the sensor.
The optimum flow velocity is between 2 to 3 m/s (6.5 to 9.8 ft/s). The velocity of flow (v), moreover, has to be matched to the physical properties of the fluid:

- v < 2 m/s (6.5 ft/s): for abrasive fluids such as potter's clay, lime milk, ore slurry etc.
- v > 2 m/s (6.5 ft/s): for fluids causing build-up such as wastewater sludges etc.

Flow characteristic values (SI units)

Diameter		Recommended flow	Factory settings		
		Min./max. full scale value	Full scale value Current output	Pulse value	Low flow
[mm]	[inch]	(v ~ 0.3 or 10 m/s)	(v ~ 2.5 m/s)	(~ 2 pulses/s)	(v ~ 0.04 m/s)
25	1"	9 to 300 dm³/min	75 dm³/min	0.50 dm³	1 dm³/min
32	–	15 to 500 dm³/min	125 dm³/min	1.00 dm³	2 dm³/min
40	1½"	25 to 700 dm³/min	200 dm³/min	1.50 dm³	3 dm³/min
50	2"	35 to 1100 dm³/min	300 dm³/min	2.50 dm³	5 dm³/min
65	–	60 to 2000 dm³/min	500 dm³/min	5.00 dm³	8 dm³/min
80	3"	90 to 3000 dm³/min	750 dm³/min	5.00 dm³	12 dm³/min
100	4"	145 to 4700 dm³/min	1200 dm³/min	10.00 dm³	20 dm³/min
125	–	220 to 7500 dm³/min	1850 dm³/min	15.00 dm³	30 dm³/min
150	6"	20 to 600 m³/h	150 m³/h	0.025 m³	2.5 m³/h
200	8"	35 to 1100 m³/h	300 m³/h	0.05 m³	5.0 m³/h
250	10"	55 to 1700 m³/h	500 m³/h	0.05 m³	7.5 m³/h
300	12"	80 to 2400 m³/h	750 m³/h	0.10 m³	10 m³/h
350	14"	110 to 3300 m³/h	1000 m³/h	0.10 m³	15 m³/h
375	15"	140 to 4200 m³/h	1200 m³/h	0.15 m³	20 m³/h
400	16"	140 to 4200 m³/h	1200 m³/h	0.15 m³	20 m³/h
450	18"	180 to 5400 m³/h	1500 m³/h	0.25 m³	25 m³/h
500	20"	220 to 6600 m³/h	2000 m³/h	0.25 m³	30 m³/h
600	24"	310 to 9600 m³/h	2500 m³/h	0.30 m³	40 m³/h
700	28"	420 to 13500 m³/h	3500 m³/h	0.50 m³	50 m³/h
–	30"	480 to 15000 m³/h	4000 m³/h	0.50 m³	60 m³/h
800	32"	550 to 18000 m³/h	4500 m³/h	0.75 m³	75 m³/h
900	36"	690 to 22500 m³/h	6000 m³/h	0.75 m³	100 m³/h
1000	40"	850 to 28000 m³/h	7000 m³/h	1.00 m³	125 m³/h
–	42"	950 to 30000 m³/h	8000 m³/h	1.00 m³	125 m³/h
1200	48"	1250 to 40000 m³/h	10000 m³/h	1.50 m³	150 m³/h
–	54"	1550 to 50000 m³/h	13000 m³/h	1.50 m³	200 m³/h
1400	–	1700 to 55000 m³/h	14000 m³/h	2.00 m³	225 m³/h
–	60"	1950 to 60000 m³/h	16000 m³/h	2.00 m³	250 m³/h
1600	–	2200 to 70000 m³/h	18000 m³/h	2.50 m³	300 m³/h
–	66"	2500 to 80000 m³/h	20500 m³/h	2.50 m³	325 m³/h
1800	72"	2800 to 90000 m³/h	23000 m³/h	3.00 m³	350 m³/h
–	78"	3300 to 100000 m³/h	28500 m³/h	3.50 m³	450 m³/h
2000	–	3400 to 110000 m³/h	28500 m³/h	3.50 m³	450 m³/h

Flow characteristic values (US units)					
Diameter		**Recommended flow rate**	**Factory settings**		
[inch]	[mm]	Min./max. full scale value (v ~ 0.3 or 10 m/s)	Full scale value Current output (v ~ 2.5 m/s)	Pulse value (~ 2 pulses/s)	Low flow (v ~ 0.04 m/s)
1"	25	2.5 to 80 gal/min	18 gal/min	0.20 gal	0.25 gal/min
–	32	4 to 130 gal/min	30 gal/min	0.20 gal	0.50 gal/min
1½"	40	7 to 190 gal/min	50 gal/min	0.50 gal	0.75 gal/min
2"	50	10 to 300 gal/min	75 gal/min	0.50 gal	1.25 gal/min
–	65	16 to 500 gal/min	130 gal/min	1 gal	2.0 gal/min
3"	80	24 to 800 gal/min	200 gal/min	2 gal	2.5 gal/min
4"	100	40 to 1250 gal/min	300 gal/min	2 gal	4.0 gal/min
–	125	60 to 1950 gal/min	450 gal/min	5 gal	7.0 gal/min
6"	150	90 to 2650 gal/min	600 gal/min	5 gal	12 gal/min
8"	200	155 to 4850 gal/min	1200 gal/min	10 gal	15 gal/min
10"	250	250 to 7500 gal/min	1500 gal/min	15 gal	30 gal/min
12"	300	350 to 10600 gal/min	2400 gal/min	25 gal	45 gal/min
14"	350	500 to 15000 gal/min	3600 gal/min	30 gal	60 gal/min
15"	375	600 to 19000 gal/min	4800 gal/min	50 gal	60 gal/min
16"	400	600 to 19000 gal/min	4800 gal/min	50 gal	60 gal/min
18"	450	800 to 24000 gal/min	6000 gal/min	50 gal	90 gal/min
20"	500	1000 to 30000 gal/min	7500 gal/min	75 gal	120 gal/min
24"	600	1400 to 44000 gal/min	10500 gal/min	100 gal	180 gal/min
28"	700	1900 to 60000 gal/min	13500 gal/min	125 gal	210 gal/min
30"	–	2150 to 67000 gal/min	16500 gal/min	150 gal	270 gal/min
32"	800	2450 to 80000 gal/min	19500 gal/min	200 gal	300 gal/min
36"	900	3100 to 100000 gal/min	24000 gal/min	225 gal	360 gal/min
40"	1000	3800 to 125000 gal/min	30000 gal/min	250 gal	480 gal/min
42"	–	4200 to 135000 gal/min	33000 gal/min	250 gal	600 gal/min
48"	1200	5500 to 175000 gal/min	42000 gal/min	400 gal	600 gal/min
54"	–	9 to 300 Mgal/min	75 Mgal/min	0.0005 Mgal	1.3 Mgal/min
–	1400	10 to 340 Mgal/min	85 Mgal/min	0.0005 Mgal	1.3 Mgal/min
60"	–	12 to 380 Mgal/min	95 Mgal/min	0.0005 Mgal	1.3 Mgal/min
–	1600	13 to 450 Mgal/min	110 Mgal/min	0.0008 Mgal	1.7 Mgal/min
66"	–	14 to 500 Mgal/min	120 Mgal/min	0.0008 Mgal	2.2 Mgal/min
72"	1800	16 to 570 Mgal/min	140 Mgal/min	0.0008 Mgal	2.6 Mgal/min
78"	–	18 to 650 Mgal/min	175 Mgal/min	0.001 Mgal	3.0 Mgal/min
–	2000	20 to 700 Mgal/min	175 Mgal/min	0.001 Mgal	3.0 Mgal/min

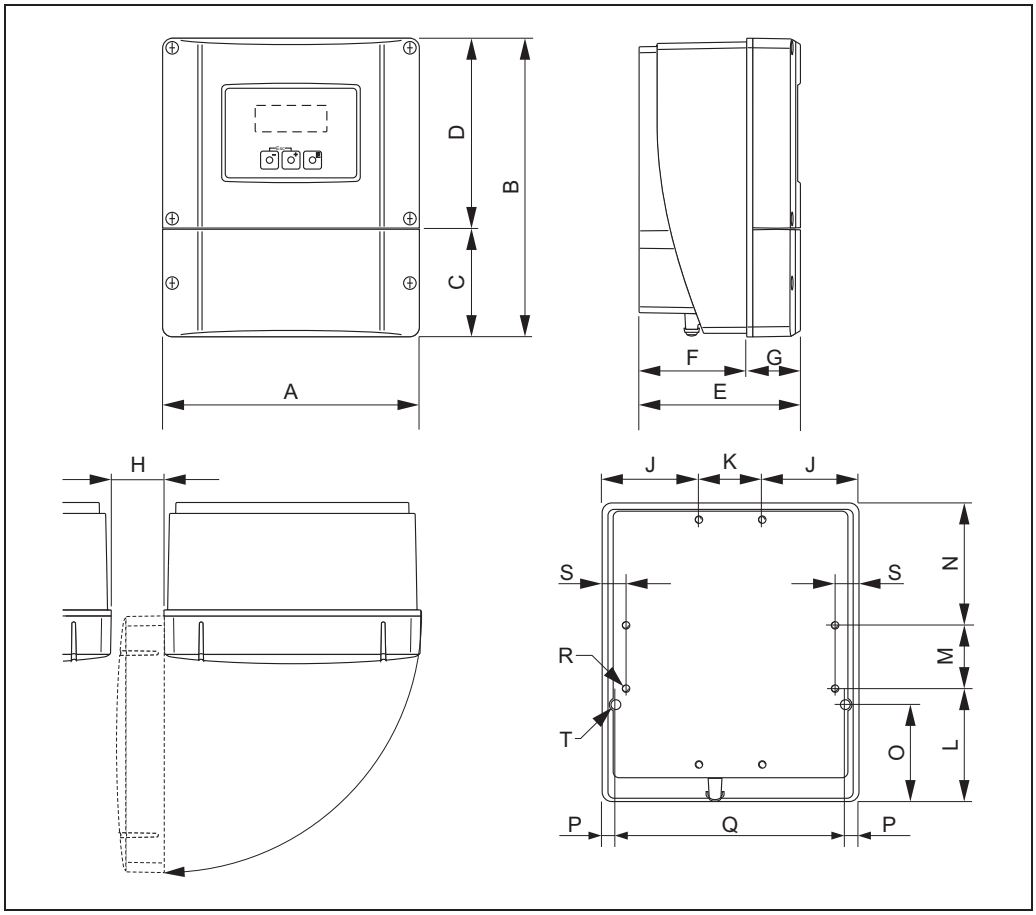
Pressure loss

- No pressure loss if the sensor is installed in a pipe with the same nominal diameter.
- Pressure losses for configurations incorporating adapters according to DIN EN 545 (→ 🖹 18, Section "Adapters").

Mechanical construction

Design, dimensions

Transmitter remote version, wall-mount housing (non Ex-zone and II3G/Zone 2)



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Dimensions (SI units)

A	B	C	D	E	F	G	H	J
215	250	90.5	159.5	135	90	45	> 50	81
K	L	M	N	O	P	Q	R	S
53	95	53	102	81.5	11.5	192	8 × M5	20

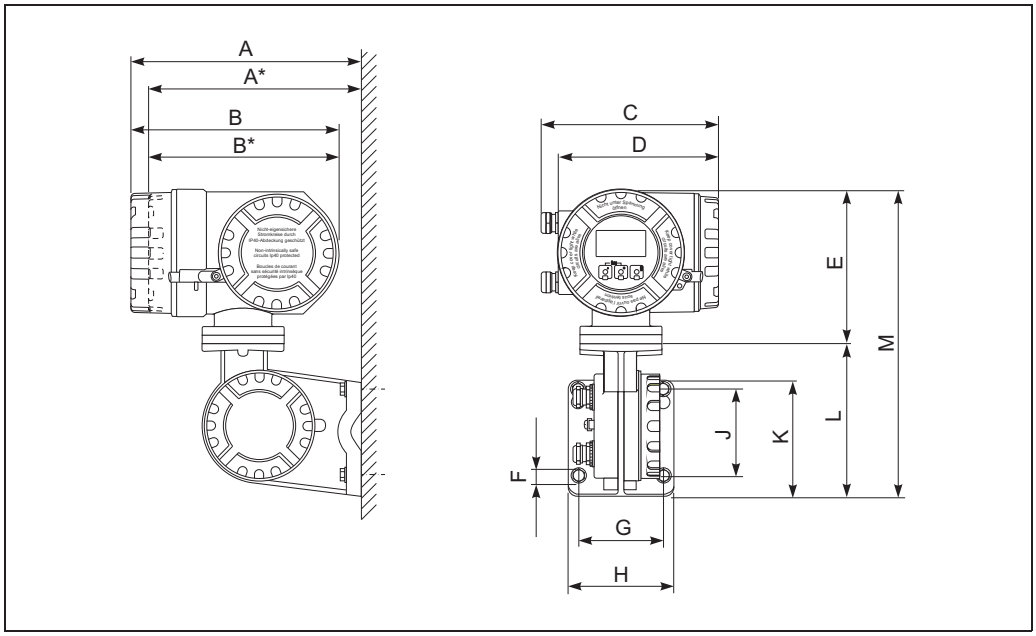
All dimensions in [mm]

Dimensions (US units)

A	B	C	D	E	F	G	H	J
8.46	9.84	3.56	6.27	5.31	3.54	1.77	> 1.97	3.18
K	L	M	N	O	P	Q	R	S
2.08	3.74	2.08	4.01	3.20	0.45	7.55	8 × M5	0.79

All dimensions in [inch]

Transmitter remote version, connection housing (II2GD/Zone 1)



Dimensions (SI units)

A	A*	B	B*	C	D	E	Ø F	G	H	J	K	L	M
265	242	240	217	206	186	178	8.6 (M8)	100	130	100	144	170	355

All dimensions in [mm]

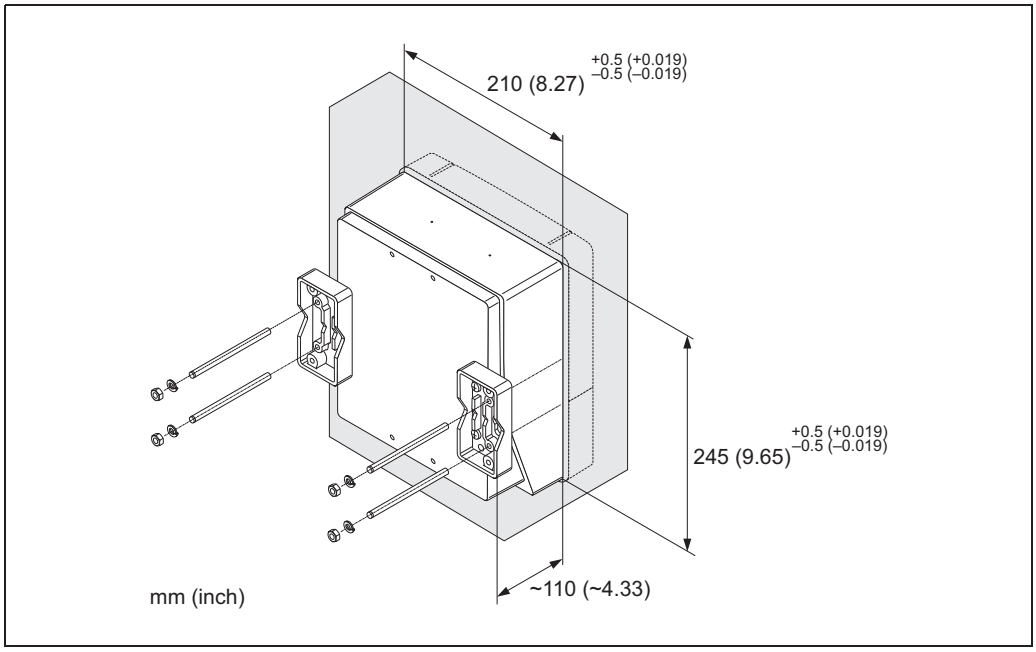
Dimensions (US units)

A	A*	B	B*	C	D	E	Ø F	G	H	J	K	L	M
10.4	9.53	9.45	8.54	8.11	7.32	7.01	0.34 (M8)	3.94	5.12	3.94	5.67	6.69	14.0

All dimensions in [inch]

There is a separate mounting kit for the wall-mounted housing. It can be ordered from Endress+Hauser as an accessory. The following installation variants are possible:
- Panel-mounted installation
- Pipe mounting

Installation in control panel



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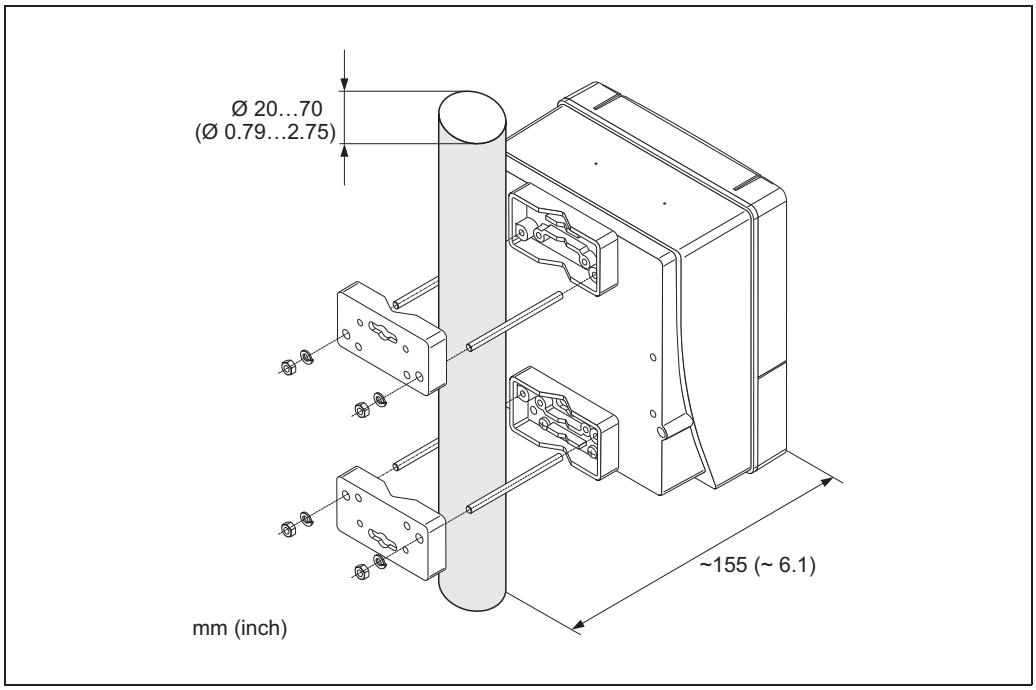
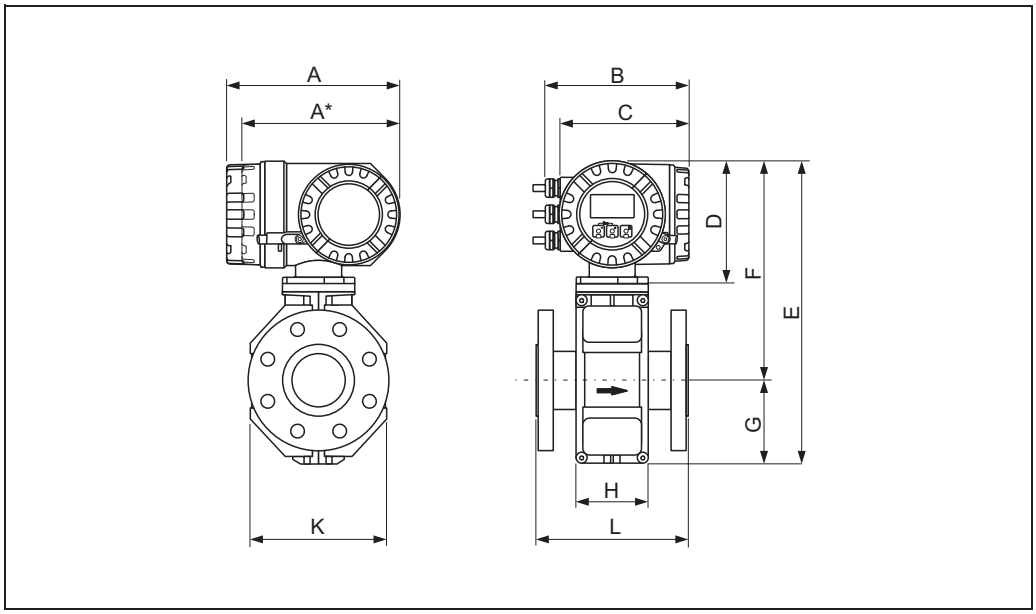
Pipe mounting



A0001132

Compact version DN ≤ 300 (12")



Dimensions (SI units)

DN EN (DIN) / JIS / AS [2]	L [1]	A	A*	B	C	D	E	F	G	H	K
25	200	227	207	187	168	160	341	257	84	94	120
32	200						341	257	84	94	120
40	200						341	257	84	94	120
50	200						341	257	84	94	120
65	200						391	282	109	94	180
80	200						391	282	109	94	180
100	250						391	282	109	94	180
125	250						472	322	150	140	260
150	300						472	322	150	140	260
200	350						527	347	180	156	324
250	450						577	372	205	166	400
300	500						627	397	230	166	460

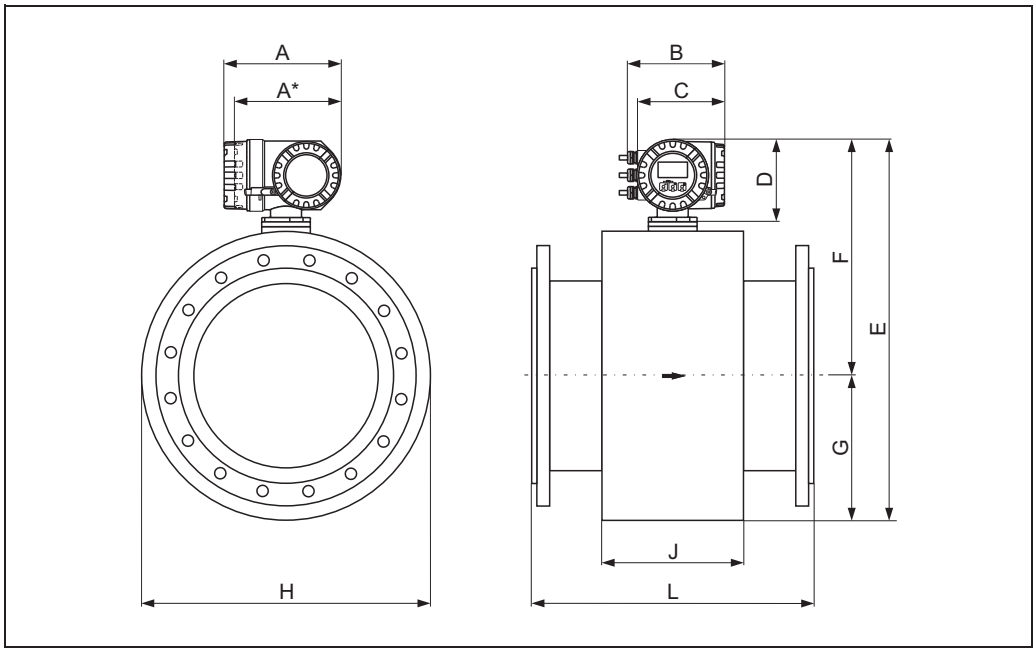
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] For flanges to AS, only the nominal diameters DN 80, 100 and 150 to 300 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	A*	B	C	D	E	F	G	H	K
1"	7.87	8.94	8.15	7.36	6.61	6.30	13.4	10.1	3.31	3.70	4.72
1½"	7.87						13.4	10.1	3.31	3.70	4.72
2"	7.87						13.4	10.1	3.31	3.70	4.72
3"	7.87						15.4	11.1	4.29	3.70	7.09
4"	9.84						15.4	11.1	4.29	3.70	7.09
6"	11.8						18.6	12.7	5.91	5.51	10.2
8"	13.8						20.8	13.7	7.09	6.14	12.8
10"	17.7						22.7	14.7	8.07	6.14	15.8
12"	19.7						24.7	15.6	9.06	6.54	18.1

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Compact version DN ≥ 350 (14")



Dimensions (SI units)

DN EN (DIN) / AS [2]	L [1]	A	A*	B	C	D	E	F	G	H	J
350	550	227	207	187	168	160	738.5	456.5	282.0	276	564
375	600						790.5	482.5	308.0	276	616
400	600						790.5	482.5	308.0	276	616
450	650						840.5	507.5	333.0	292	666
500	650						891.5	533.0	358.5	292	717
600	780						995.5	585.0	410.5	402	821
700	910						1198.5	686.5	512.0	589	1024
750	975						1198.5	686.5	512.0	626	1024
800	1040						1241.5	708.5	533.5	647	1067
900	1170						1394.5	784.5	610.0	785	1220
1000	1300						1546.5	860.5	686.0	862	1372
1050	1365						1598.5	886.5	712.0	912	1424
1200	1560						1796.5	985.5	811.0	992	1622
1350	1755						1998.5	1086.5	912.0	1252	1824
1400	1820						2148.5	1161.5	987.0	1252	1974
1500	1950						2196.5	1185.5	1011.0	1392	2022
1600	2080						2286.5	1230.5	1056.0	1482	2112
1650	2145						2360.5	1267.5	1093.0	1482	2186
1800	2340						2550.5	1362.5	1188.0	1632	2376
2000	2600						2650.5	1412.5	1238.0	1732	2476

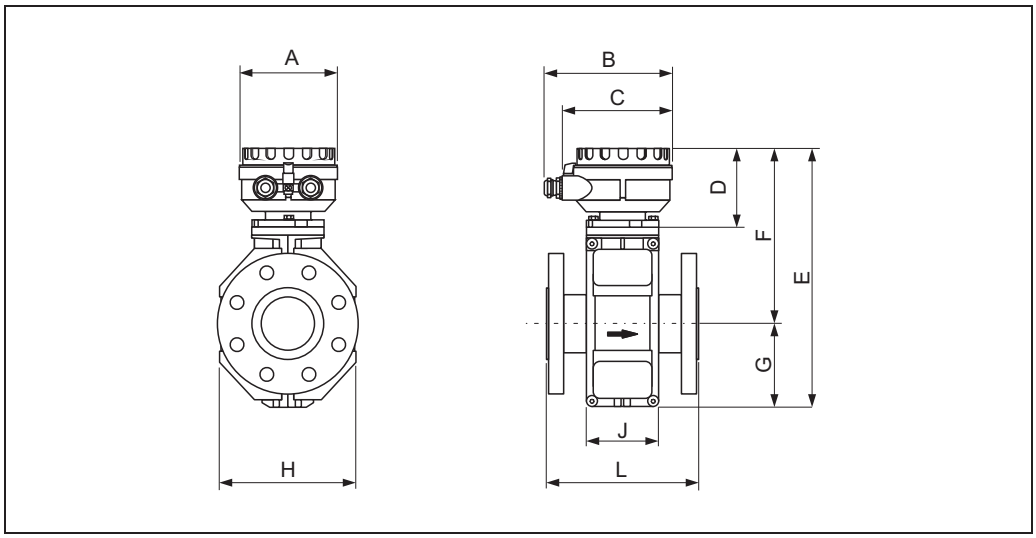
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] For flanges to AS, only DN 350, 400, 500 and 600 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI / AWWA [2]	L [1]	A	A*	B	C	D	E	F	G	H	J
14"	21.6	8.94	8.15	7.36	6.61	6.30	29.1	17.9	11.1	10.9	22.2
15"	23.6						31.1	18.9	12.1	10.9	24.2
16"	23.6						31.1	18.9	12.1	10.9	24.2
18"	25.6						33.1	19.9	13.1	11.5	26.2
20"	25.6						35.1	20.9	14.1	11.5	28.2
24"	30.7						39.2	23.0	16.2	15.8	32.3
28"	35.8						47.2	27.0	20.1	23.2	40.3
30"	38.4						47.2	27.0	20.1	24.6	40.3
32"	40.9						48.9	27.9	21.0	25.5	42.0
36"	46.0						54.9	30.9	24.0	30.9	48.0
40"	51.2						60.9	33.9	27.0	33.9	54.0
42"	53.7						62.9	34.9	28.0	35.9	56.0
48"	61.4						71.7	38.8	31.9	39.0	63.8
54"	69.1						78.7	42.8	35.9	42.3	71.8
56"	71.7						84.6	45.7	38.9	49.3	77.7
60"	76.8						86.5	46.7	39.8	54.8	79.6
64"	81.9						90.0	48.4	41.6	58.4	83.2
66"	84.4						92.9	49.9	43.0	58.4	86.0
72"	92.1						100.4	53.6	46.8	64.2	93.5
78"	102.3						104.3	55.6	48.7	68.2	97.5

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] Flanges ≤ 24" only to ANSI available, ≥ 28" only to AWWA available.
All dimensions in [inch]

Sensor, remote version DN ≤ 300 (12")



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Dimensions (SI units)

DN EN (DIN) / JIS / AS [2]	L [1]	A	B	C	D	E	F	G	H	J
25	200	129	163	143	102	286	202	84	120	94
32	200	129	163	143	102	286	202	84	120	94
40	200	129	163	143	102	286	202	84	120	94
50	200	129	163	143	102	286	202	84	120	94
65	200	129	163	143	102	336	227	109	180	94
80	200	129	163	143	102	336	227	109	180	94
100	250	129	163	143	102	336	227	109	180	94
125	250	129	163	143	102	417	267	150	260	140
150	300	129	163	143	102	417	267	150	260	140
200	350	129	163	143	102	472	292	180	324	156
250	450	129	163	143	102	522	317	205	400	166
300	500	129	163	143	102	572	342	230	460	166

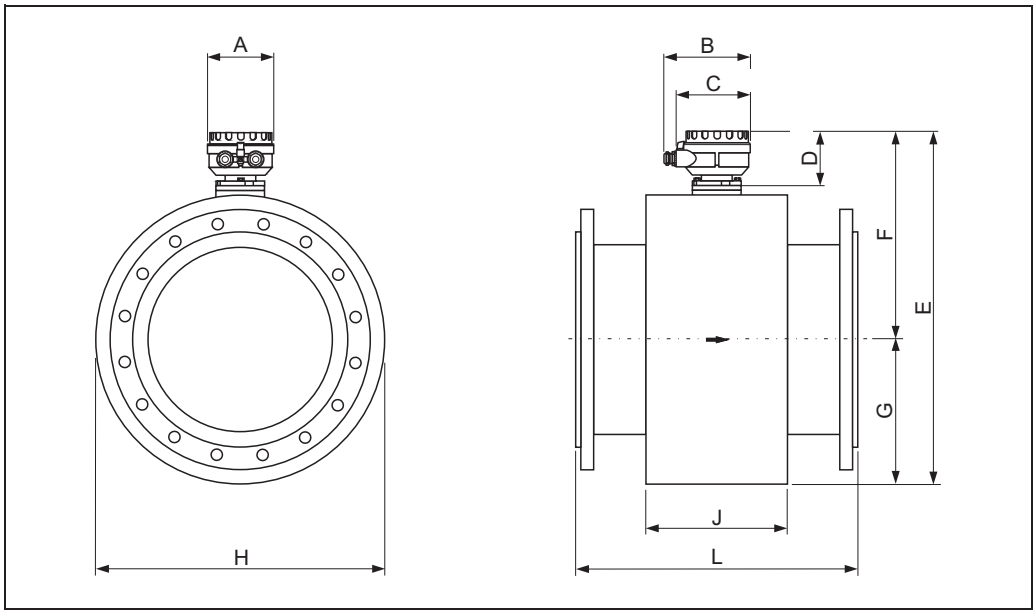
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] For flanges to AS, only the nominal diameters DN 80, 100 and 150 to 300 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI	L [1]	A	B	C	D	E	F	G	H	J
1"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.32	4.72	3.70
1½"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.32	4.72	3.70
2"	7.87	5.08	6.42	5.63	4.02	11.3	7.95	3.32	4.72	3.70
3"	7.87	5.08	6.42	5.63	4.02	13.2	8.94	4.30	7.10	3.70
4"	9.84	5.08	6.42	5.63	4.02	13.2	8.94	4.30	7.10	3.70
6"	11.8	5.08	6.42	5.63	4.02	16.4	10.5	5.91	10.2	5.51
8"	13.8	5.08	6.42	5.63	4.02	18.6	11.5	7.10	12.8	6.14
10"	17.7	5.08	6.42	5.63	4.02	20.6	12.5	8.08	15.8	6.14
12"	19.7	5.08	6.42	5.63	4.02	22.5	13.5	9.06	18.1	6.54

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
All dimensions in [inch]

Sensor, remote version DN ≥ 350 (14")



Dimensions (SI units)

DN EN (DIN) / AS [2]	L [1]	A	B	C	D	E	F	G	H	J
350	550	129	163	143	102	683.5	401.5	282.0	564	276
375	600					735.5	427.5	308.0	616	276
400	600					735.5	427.5	308.0	616	276
450	650					785.5	452.5	333.0	666	292
500	650					836.5	478.0	358.5	717	292
600	780					940.5	530.0	410.5	821	402
700	910					1143.5	631.5	512.0	1024	589
750	975					1143.5	631.5	512.0	1024	626
800	1040					1186.5	653.0	533.5	1067	647
900	1170					1339.5	729.5	610.0	1220	785
1000	1300					1491.5	805.5	686.0	1372	862
1050	1365					1543.5	831.5	712.0	1424	912
1200	1560					1741.5	930.5	811.0	1622	992
1350	1755					1943.5	1031.5	912.0	1824	1252
1400	1820					2093.5	1106.5	987.0	1974	1252
1500	1950					2141.5	1130.5	1011.0	2022	1392
1600	2080					2231.5	1175.5	1056.0	2112	1482
1650	2145					2305.5	1212.5	1093.0	2186	1482
1800	2340					2495.5	1307.5	1188.0	2376	1632
2000	2600					2595.5	1357.5	1238.0	2476	1732

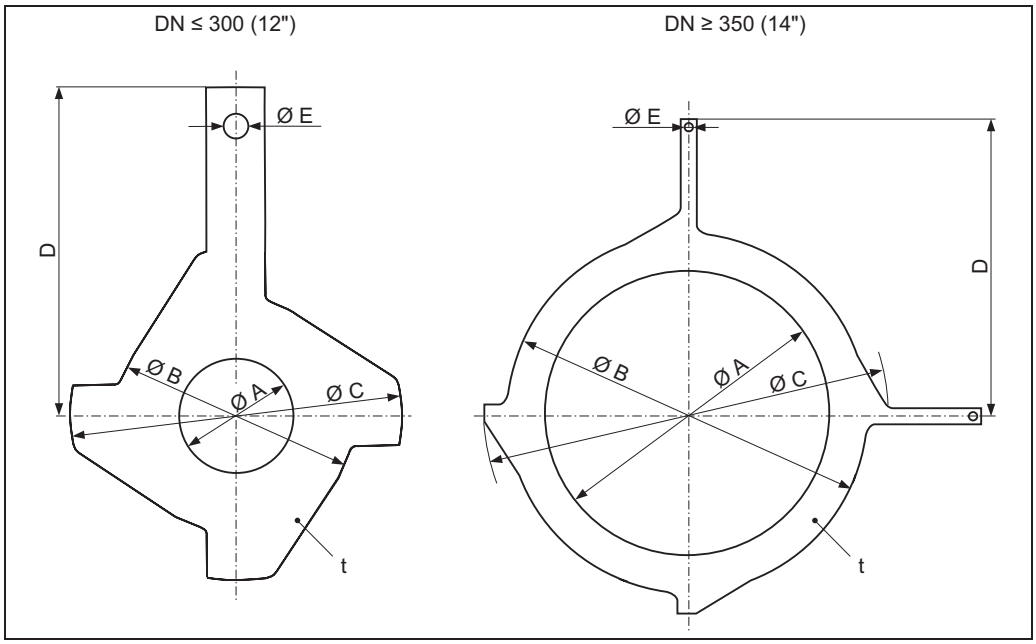
[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] For flanges to AS, only DN 350, 400, 500 and 600 are available.
All dimensions in [mm]

Dimensions (US units)

DN ANSI / AWWA [2]	L [1]	A	B	C	D	E	F	G	H	J
14"	21.6	5.08	6.42	5.63	4.02	29.1	15.8	11.1	22.2	10.9
15"	23.6					31.1	16.8	12.1	24.2	10.9
16"	23.6					31.1	16.8	12.1	24.2	10.9
18"	25.6					33.1	17.8	13.1	26.2	11.5
20"	25.6					35.1	18.8	14.1	28.2	11.5
24"	30.7					39.2	20.9	16.2	32.3	15.8
28"	35.8					45.0	24.9	20.1	40.3	23.2
30"	38.4					45.0	24.9	20.1	40.3	24.6
32"	40.9					46.7	25.7	21.0	42.0	25.5
36"	46.0					52.7	28.7	24.0	48.0	30.9
40"	51.2					58.7	31.7	27.0	54.0	33.9
42"	53.7					60.7	32.7	28.0	56.0	35.9
48"	61.4					68.5	36.6	31.9	63.8	39.0
54"	69.1					76.5	40.6	35.9	71.8	42.3
56"	71.7					82.4	43.6	38.9	77.7	49.3
60"	76.8					84.3	44.5	39.8	79.6	54.8
64"	81.9					87.9	46.3	41.6	83.2	58.4
66"	84.4					90.8	47.7	43.0	86.0	58.4
72"	92.1					98.2	51.5	46.8	93.5	64.2
78"	102.3					102.2	53.4	48.7	97.5	68.2

[1] The length is regardless of the pressure rating selected. Fitting length to DVGW.
[2] Flanges ≤ 24" only to ANSI available, ≥ 28" only to AWWA available.
All dimensions in [inch]

Ground disk for flange connections



Dimensions (SI units)

DN [1] EN (DIN) / JIS / AS [2]	A	B	C	D	E	t
25	26	62	77.5	87.5	6.5	2
32	35	80	87.5	94.5		
40	41	82	101	103		
50	52	101	115.5	108		
65	68	121	131.5	118		
80	80	131	154.5	135		
100	104	156	186.5	153		
125	130	187	206.5	160		
150	158	217	256	184		
200	206	267	288	205		
250	260	328	359	240		
300 [3]	312	375	413	273		
300 [4]	310	375	404	268		
350 [3]	343	433	479	365	9.0	
375 [3]	393	480	542	395		
400 [3]	393	480	542	395		
450 [3]	439	538	583	417		
500 [3]	493	592	650	460		
600 [3]	593	693	766	522		

[1] Ground disks can be used for all flange standards/pressure ratings that can be delivered, except for DN ≥ 300.
[2] Only DN 32, 40, 65 and 125 are available for flanges according to AS.
[3] PN 10/16
[4] PN 25, JIS 10K/20K
All dimensions in [mm]

Dimensions (US units)

DN [1] ANSI	A	B	C	D	E	t
1"	1.02	2.44	3.05	3.44	0.26	0.08
1½"	1.61	3.23	3.98	4.06		
2"	2.05	3.98	4.55	4.25		
3"	3.15	5.16	6.08	5.31		
4"	4.09	6.14	7.34	6.02		
6"	6.22	8.54	10.08	7.24		
8"	8.11	10.5	11.3	8.07		
10"	10.2	12.9	14.1	9.45		
12"	12.3	14.8	16.3	10.8		
14"	13.5	17.1	18.9	14.4	0.35	
15"	15.45	18.9	21.3	15.6		
16"	15.45	18.9	21.3	15.6		
18"	17.3	21.2	23.0	16.4		
20"	19.4	23.3	25.6	18.1		
24"	23.4	27.3	30.1	20.6		

[1] Ground disks can be used for all flange standards/pressure ratings.
All dimensions in [inch]

Weight

Weight in SI units

Weight data in kg

Nominal diameter		Compact version						Remote version (without cable)						
								Sensor						Transmitter
[mm]	[inch]	EN (DIN) / AS [1]		JIS		ANSI / AWWA		EN (DIN) / AS [1]		JIS		ANSI / AWWA		Wall-mount housing
25	1"	PN 40	7.3	10K	7.3	Class 150	7.3	PN 40	5.3	10K	5.3	Class 150	5.3	6.0
32	–		8.0		7.3		–		6.0		5.3		–	
40	1½"		9.4		8.3		9.4		7.4		6.3		7.4	
50	2"		10.6		9.3		10.6		8.6		7.3		8.6	
65	–	PN 16	12		11.1		–	PN 16	10.0		9.1		–	
80	3"		14		112.5		14.0		12.0		10.5		12.0	
100	4"		16		14.7		16.0		14.0		12.7		14.0	
125	–		21.5		21.0		–		19.5		19.0		–	
150	6"		25.5		24.5		25.5		23.5		22.5		23.5	
200	8"	PN 10	45		41.9		45	PN 10	43		39.9		43	
250	10"		65		69.4		75		63		67.4		73	
300	12"		70		72.3		110		68		70.3		108	
350	14"	PN 6	105				175	PN 6	103				173	
375	15"		120				–		118				–	
400	16"		120				205		118				203	
450	18"		161				255		159				253	
500	20"		156				285		154				283	
600	24"		208				405		206				403	
700	28"		304			Class D	400		302			Class D	398	
–	30"		–				460		–				458	
800	32"		357				550		355				548	
900	36"		485				800		483				798	
1000	40"		589				900		587				898	
–	42"		–				1100		–				1098	
1200	48"		850				1400		848				1398	
–	54"		–				2200		–				2198	
1400	–		1300				–		1298				–	
–	60"		–				2700		–				2698	
1600	–		1700				–		1698				–	
–	66"		–				3700		–				3698	
1800	72"		2200				4100		2198				4098	
–	78"		–				4600		–				4598	
2000	–		2800				–		2798				–	

[1] For flanges to AS, only DN 80, 100, 150 to 400, 500 and 600 are available.

- Transmitter (compact version): 3.4 kg
- Weight data valid for standard pressure ratings and without packaging material.

Weight in US units (only ANSI / AWWA)

Weight data in lbs						
Nominal diameter		Compact version		Remote version (without cable)		
				Sensor		Transmitter
[mm]	[inch]		ANSI /AWWA		ANSI / AWWA	Wall-mount housing
25	1"	Class 150	16.1	Class 150	11.7	13.2
40	1½"		20.7		16.3	
50	2"		23.4		19.0	
80	3"		30.9		26.5	
100	4"		35.3		30.9	
150	6"		56.2		51.8	
200	8"		99.2		94.8	
250	10"		165.4		161.0	
300	12"		242.6		238.1	
350	14"		385.9		381.5	
400	16"		452.0		447.6	
450	18"		562.3		557.9	
500	20"		628.4		624.0	
600	24"		893.0		888.6	
700	28"	Class D	882.0	Class D	877.6	
–	30"		1014.3		1009.9	
800	32"		1212.8		1208.3	
900	36"		1764.0		1759.6	
1000	40"		1984.5		1980.1	
–	42"		2425.5		2421.1	
1200	48"		3087.0		3082.6	
–	54"		4851.0		4846.6	
–	60"		5953.5		5949.1	
–	66"		8158.5		8154.1	
1800	72"		9040.5		9036.1	
–	78"		10143.0		10138.6	

- Transmitter (compact version): 7,5 lbs
- Weight data valid for standard pressure ratings and without packaging material.

Measuring tube specifications

Diameter		Pressure rating						Internal diameter			
		EN (DIN)	AS 2129	AS 4087	ANSI	AWWA	JIS	Hard rubber		Polyurethane	
[mm]	[inch]	[bar]			[lbs]			[mm]	[inch]	[mm]	[inch]
25	1"	PN 40	–	–	Cl. 150	–	20 K	–	–	24	0.94
32	–	PN 40	–	–	–	–	20 K	–	–	32	1.26
40	1½"	PN 40	–	–	Cl. 150	–	20 K	–	–	38	1.50
50	2"	PN 40	Table E	PN 16	Cl. 150	–	10 K	50	1.97	50	1.97
65	–	PN 16	–	–	–	–	10 K	66	2.60	66	2.60
80	3"	PN 16	Table E	PN 16	Cl. 150	–	10 K	79	3.11	79	3.11
100	4"	PN 16	Table E	PN 16	Cl. 150	–	10 K	102	4.02	102	4.02
125	–	PN 16	–	–	–	–	10 K	127	5.00	127	5.00
150	6"	PN 16	Table E	PN 16	Cl. 150	–	10 K	156	6.14	156	6.14
200	8"	PN 10	Table E	PN 16	Cl. 150	–	10 K	204	8.03	204	8.03
250	10"	PN 10	Table E	PN 16	Cl. 150	–	10 K	258	10.2	258	10.2
300	12"	PN 10	Table E	PN 16	Cl. 150	–	10 K	309	12.2	309	12.2
350	14"	PN 6	Table E	PN 16	Cl. 150	–	–	342	13.5	342	13.5
375	15"	–	–	PN 16	–	–	–	392	15.4	–	–
400	16"	PN 6	Table E	PN 16	Cl. 150	–	–	392	15.4	392	15.4
450	18"	PN 6	–	–	Cl. 150	–	–	437	17.2	437	17.2
500	20"	PN 6	Table E	PN 16	Cl. 150	–	–	492	19.4	492	19.4
600	24"	PN 6	Table E	PN 16	Cl. 150	–	–	594	23.4	594	23.4
700	28"	PN 6	–	–	–	Class D	–	692	27.2	692	27.2
–	30"	–	–	–	–	Class D	–	742	29.2	742	29.2
800	32"	PN 6	–	–	–	Class D	–	794	31.3	794	31.3
900	36"	PN 6	–	–	–	Class D	–	891	35.1	891	35.1
1000	40"	PN 6	–	–	–	Class D	–	994	39.1	994	39.1
–	42"	–	–	–	–	Class D	–	1043	41.1	1043	41.1
1200	48"	PN 6	–	–	–	Class D	–	1197	47.1	1197	47.1
–	54"		–	–	–	Class D	–	1339	52.7	–	–
1400	–	PN 6	–	–	–	–	–	1402	55.2	–	–
–	60"	–	–	–	–	Class D	–	1492	58.7	–	–
1600	–	PN 6	–	–	–	–	–	1600	63.0	–	–
–	66"	–	–	–	–	Class D	–	1638	64.5	–	–
1800	72"	PN 6	–	–	–	Class D	–	1786	70.3	–	–
2000	78"	PN 6	–	–	–	Class D	–	1989	78.3	–	–

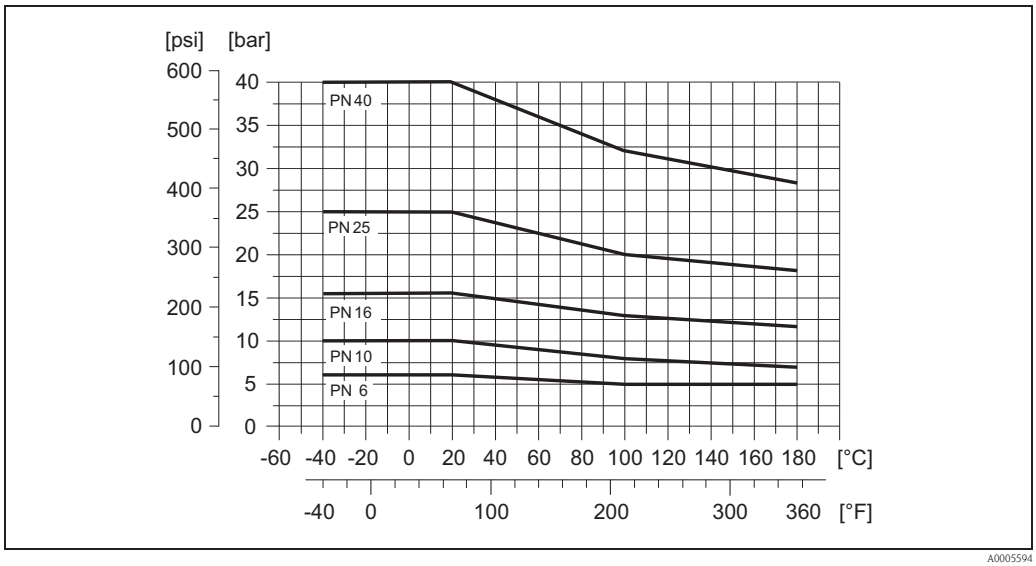
Material

- Transmitter housing
  - Compact housing: powder-coated die-cast aluminum
  - Wall-mount housing: powder-coated die-cast aluminum
- Sensor housing
  - DN 25 to 300 (1 to 12"): powder-coated die-cast aluminum
  - DN 350 to 2000 (14 to 78"): with protective lacquering
- Measuring tube
  - DN ≤ 300 (12"): stainless steel 1.4301 or 1.4306/304L; (for flanges made of carbon steel with Al/Zn protective coating)
  - DN ≥ 350 (14"): stainless steel 1.4301 or 1.4306/304L; (for flanges made of carbon steel with Al/Zn protective coating)
- Electrodes: 1.4435, Alloy C-22, Tantalum
- Flanges
  - EN 1092-1 (DIN 2501): 1.4571/316L; RSt37-2 (S235JRG2); C22; FE 410W B (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - ANSI: A105; F316L (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - AWWA: 1.0425
  - JIS: RSt37-2 (S235JRG2); HII; 1.0425/316L (DN ≤ 300 (12"): with Al/Zn protective coating; DN ≥ 350 (14") with protective lacquering)
  - AS 2129
    - DN 150 to 300, 600 (6 to 12", 24"): A105 or RSt37-2 (S235JRG2)
    - DN 50, 80, 100, 350, 400, 500 (2", 3", 4", 14", 16", 20"): A105 or St44-2 (S275JR)
  - AS 4087: A105 or St44-2 (S275JR)
- Seals: to DIN EN 1514-1
- Ground disks: 1.4435/316L, Alloy C-22, Tantalum

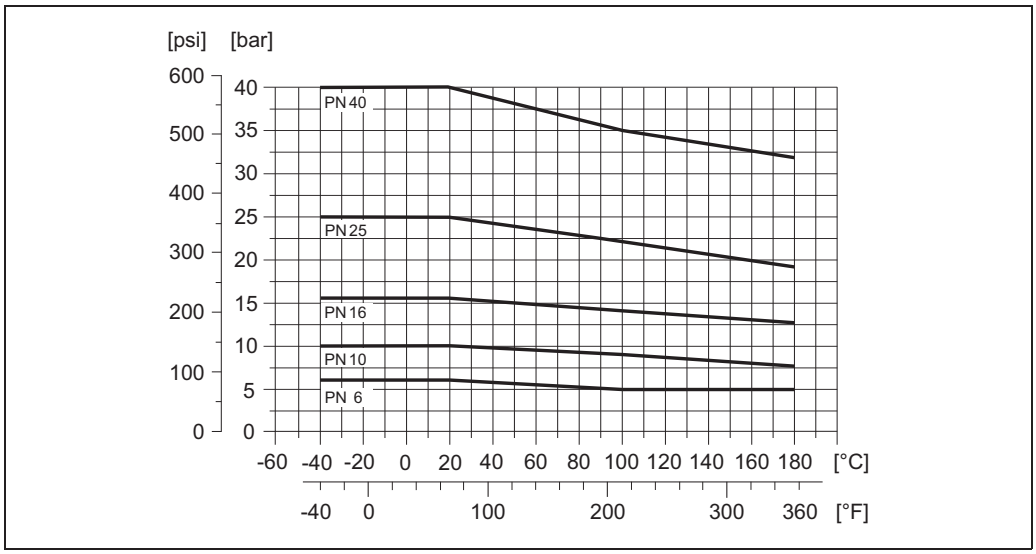
Material load diagram

Caution!
The following diagrams contain material load diagrams (reference curves) for flange materials with regard to the medium temperature. However, the maximum medium temperatures permitted always depend on the lining material of the sensor and/or the sealing material (→ 21).

Flange connection to EN 1092-1 (DIN 2501)
Material: RSt37-2 (S235JRG2) / C22 / Fe 410W B

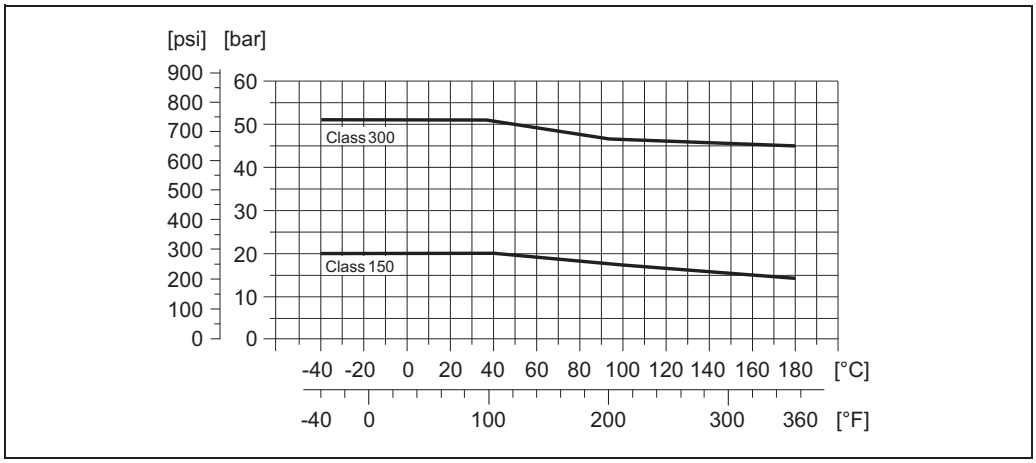


Flange connection to EN 1092-1 (DIN 2501)
Material: 316L / 1.4571



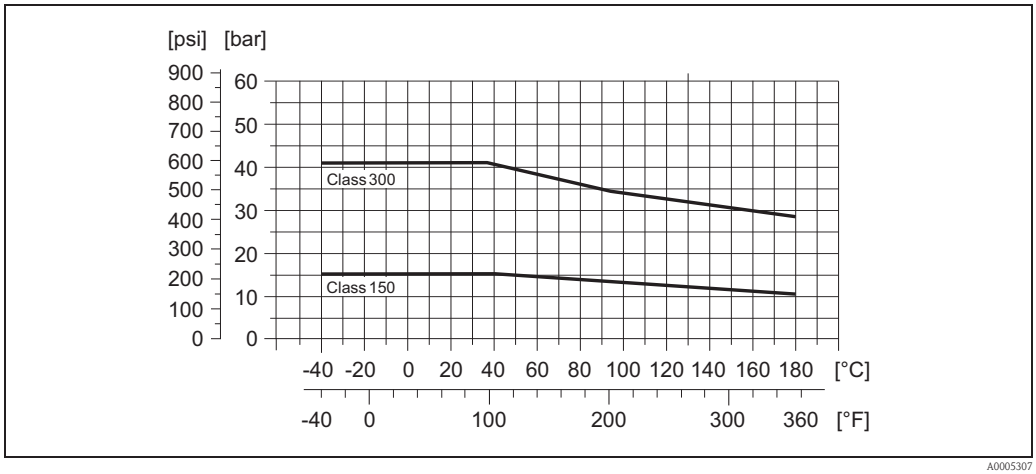
A0005304

Flange connection to ANSI B16.5
Material: A 105



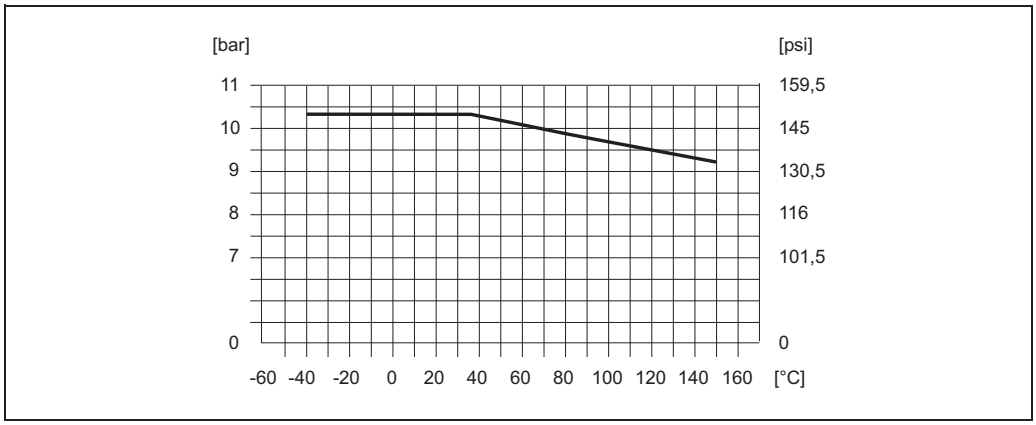
A0003226

Flange connection to ANSI B16.5
Material: F316L

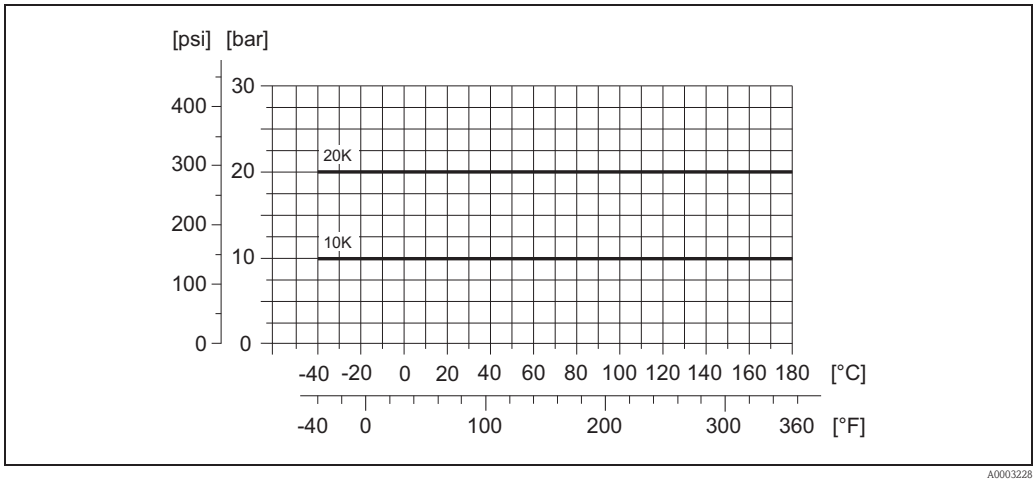


A0005307

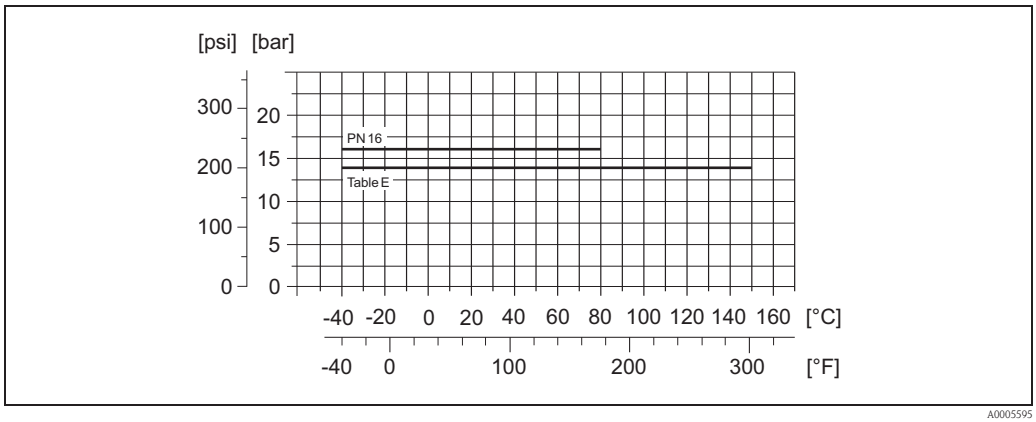
Flange connection to AWWA C 207, Class D
Material: 1.0425



Flange connection to JIS B2220
Material: RSt37-2 (S235JRG2) / HII / 1.0425 / 316L



Flange connection to AS 2129 Table E or AS 4087 PN 16
Material: A105 / RSt37-2 (S235JRG2) / St44-2 (S275JR)



Fitted electrodes

Measuring electrodes, reference electrodes and empty pipe detection electrodes:
- Standard available with 1.4435, Alloy C-22, tantalum
- Optional: exchangeable measuring electrodes made of 1.4435 (DN 350 to 2000 / 14 to 78")

Process connections

Flange connection:
- EN 1092-1 (DIN 2501), DN ≤ 300 (12") form A, DN ≥ 350 (14") form B
  (Dimensions to DIN 2501, DN 65 PN 16 and DN 600 (24") PN 16 exclusively to EN 1092-1)
- ANSI B16.5
- AWWA C 207, Class D
- JIS B2220
- AS 2129 Table E
- AS 4087 PN 16

Surface roughness

- Elektroden
  – 1.4435, Alloy C-22, tantal: ≤ 0.3 to 0.5 µm (≤ 11.8 to 19.7 µin)

(all data refer to parts in contact with medium)

Human interface

Display elements

- Liquid crystal display: backlit, two lines (Promag 50) or four lines (Promag 53) with 16 characters per line
- Custom configurations for presenting different measured-value and status variables
- Totalizer
  - Promag 50: 2 totalizers
  - Promag 53: 3 totalizers

Operating elements

Unified operation concept for both types of transmitter:

Promag 50:
- Local operation via three keys (−, +, E)
- Quick Setup menus for straightforward commissioning

Promag 53:
- Local operation via three keys (−, +, E)
- Application-specific Quick Setup menus for straightforward commissioning

Language groups

Language groups available for operation in different countries:

Promag 50, Promag 53:
- Western Europe and America (WEA):
  English, German, Spanish, Italian, French, Dutch, Portuguese
- Eastern Europe and Scandinavia (EES):
  English, Russian, Polish, Norwegian, Finnish, Swedish, Czech
- South and east Asia (SEA):
  English, Japanese, Indonesian

Promag 53:
- China (CN):
  English, Chinese

You can change the language group via the operating program "FieldCare".

Remote operation

- Promag 50: Remote control via HART, PROFIBUS DP/PA
- Promag 53: Remote control via HART, PROFIBUS DP/PA, MODBUS RS485, FOUNDATION Fieldbus

Certificates and approvals

CE mark

The measuring system is in conformity with the statutory requirements of the EC Directives. Endress+Hauser confirms successful testing of the device by affixing to it the CE mark.

C-tick mark

The measuring system meets the EMC requirements of the "Australian Communications and Media Authority (ACMA)".

Pressure measuring device approval

Measuring devices with a nominal diameter smaller than or equal to DN 25 correspond to Article 3(3) of the EC Directive 97/23/EC (Pressure Equipment Directive) and have been designed and manufactured according to good engineering practice. Where necessary (depending on the medium and process pressure), there are additional optional approvals to Category II/III for larger nominal diameters.

Ex approval

Information about currently available Ex versions (ATEX, IECEx, FM, CSA, NEPSI) can be supplied by your Endress+Hauser Sales Center on request. All explosion protection data are given in a separate documentation which is available upon request.

Other standards and guidelines

- EN 60529
  Degrees of protection by housing (IP code)
- EN 61010
  Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures.
- IEC/EN 61326
  “Emission in accordance with requirements for Class A”.
  Electromagnetic compatibility (EMC requirements)
- NAMUR NE 21:
  Electromagnetic compatibility (EMC) of industrial process and laboratory control equipment.
- NAMUR NE 43:
  Standardization of the signal level for the breakdown information of digital transmitters with analog output signal.
- NAMUR NE 53:
  Software of field devices and signal-processing devices with digital electronics.
- ANSI/ISA-S82.01
  Safety Standard for Electrical and Electronic Test, Measuring, Controlling and related Equipment - General Requirements Pollution degree 2, Installation Category II.
- CAN/CSA-C22.2 No. 1010.1-92
  Safety requirements for Electrical Equipment for Measurement and Control and Laboratory Use. Pollution degree 2, Installation Category II

FOUNDATION Fieldbus certification

The flow device has successfully passed all the test procedures carried out and is certified and registered by the Fieldbus Foundation. The device thus meets all the requirements of the following specifications:

- Certified to FOUNDATION Fieldbus Specification
- The device meets all the specifications of the FOUNDATION Fieldbus H1.
- Interoperability Test Kit (ITK), revision status 5.01 (device certification number: on request)
- The device can also be operated with certified devices of other manufacturers
- Physical Layer Conformance Test of the Fieldbus Foundation

MODBUS RS485 certification

The measuring device meets all the requirements of the MODBUS/TCP conformity test and has the “MODBUS/TCP Conformance Test Policy, Version 2.0”. The measuring device has successfully passed all the test procedures carried out and is certified by the “MODBUS/TCP Conformance Test Laboratory” of the University of Michigan.

PROFIBUS DP/PA certification

The flow device has successfully passed all the test procedures carried out and is certified and registered by the PNO (PROFIBUS User Organisation). The device thus meets all the requirements of the following specifications:

- Certified to PROFIBUS PA, profile version 3.0 (device certification number: on request)
- The device can also be operated with certified devices of other manufacturers (interoperability)

Ordering information

Your Endress+Hauser service organization can provide detailed ordering information and information on the order codes on request.

Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the transmitter and the sensor. Your Endress+Hauser service organization can provide detailed information on the order codes in question.

Documentation

- Flow Measurement (FA005D/06)
- Operating Instructions Promag Promag 50 (BA046D/06 and BA049D/06)
- Operating Instructions Promag Promag 50 PROFIBUS PA (BA055D/06 and BA056D/06)
- Operating Instructions Promag Promag 53 (BA047D/06 and BA048D/06)
- Operating Instructions Promag Promag 53 FOUNDATION Fieldbus (BA051D/06 and BA052D/06)
- Operating Instructions Promag Promag 53 MODBUS RS485 (BA117D/06 and BA118D/06)
- Operating Instructions Promag Promag 53 PROFIBUS DP/PA (BA053D/06 and BA054D/06)
- Supplementary documentation on Ex-ratings: ATEX, IECEx, FM, CSA, NEPSI

Registered trademarks

HART®
Registered trademark of the HART Communication Foundation, Austin, USA

PROFIBUS®
Registered trademark of the PROFIBUS Nutzerorganisation e.V., Karlsruhe, D

FOUNDATION™ Fieldbus
Registered trademark of the Fieldbus Foundation, Austin, USA

MODBUS®
Registered trademark of the MODBUS Organisation

HistoROM™, S-DAT®, T-DAT™, F-CHIP®, FieldCare®, Fieldcheck®, FieldXpert™, Applicator®
Registered or registration-pending trademarks of Endress+Hauser Flowtec AG, Reinach, CH

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Endress+Hauser

People for Process Automation

TI046D/06/en/11.09
71106269
FM+SGML6.0 ProMoDo

Technical Information
Deltabar S
PMD75, FMD77, FMD78

Differential pressure measurement and pressure measurement

Differential pressure transmitter with metal sensors

Applications

The device is used for the following measuring tasks:
- Flow measurement (volume flow or mass flow) in conjunction with differential pressure sensors in gases, vapors and liquids
- Level, volume or mass measurements in liquids
- High process temperatures up to 400 °C (752 °F) possible with diaphragm seal mount
- Differential pressure monitoring, e.g. of filters and pumps

Your benefits

- Very good reproducibility and long-term stability
- High reference accuracy up to 0.035 %
- Turn down up to 100:1, higher on request
- Used for flow and differential pressure monitoring up to SIL3, certified to IEC 61508 by TÜV SÜD
- High level of safety during operation thanks to function monitoring from the measuring cell to the electronics
- The patented TempC membrane for the diaphragm seal reduces measured errors caused by environmental and process temperature influences to a minimum
- Easy electronic replacement guaranteed with HistoROM®/M-DAT
- Uniform platform for differential pressure, hydrostatics and pressure (Deltabar S – Deltapilot S – Cerabar S)
- Practical user navigation for quick and easy commissioning
- Extensive diagnostic functions
- Cost-effective installation with Deltabar S FMD77, capillary on low-pressure side

Endress+Hauser
People for Process Automation

Table of contents

Document information

Document function

The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

Symbols used

Safety symbols

Symbol	Meaning
DANGER	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
WARNING	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
CAUTION	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	**NOTE!** This symbol contains information on procedures and other facts which do not result in personal injury.

Electrical symbols

Symbol	Meaning	Symbol	Meaning
	**Protective ground connection** A terminal which must be connected to ground prior to establishing any other connections.		**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.

Symbols for certain types of information

Symbol	Meaning
	**Permitted** Procedures, processes or actions that are permitted.
	**Preferred** Procedures, processes or actions that are preferred.
	**Forbidden** Procedures, processes or actions that are forbidden.
	**Tip** Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
	Visual inspection

Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
1., 2., 3., ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections

Documentation

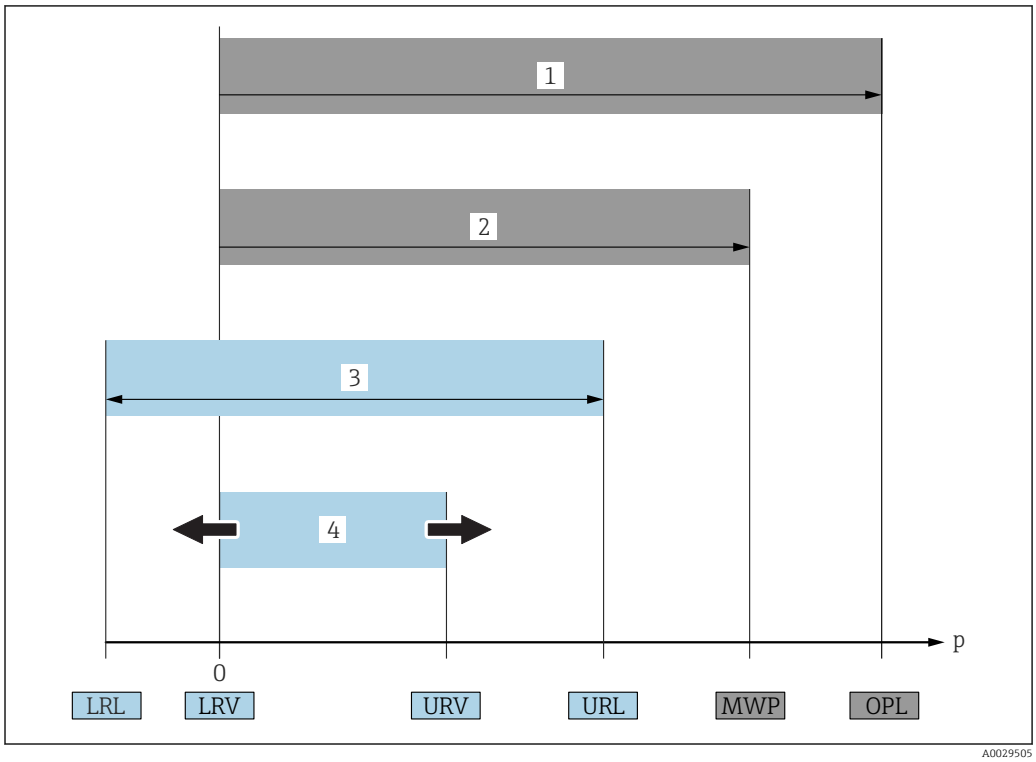
See chapter "Additional documentation" → 113

The document types listed are available:
In the Download Area of the Endress+Hauser Internet site: www.endress.com → Download

Safety Instructions (XA)

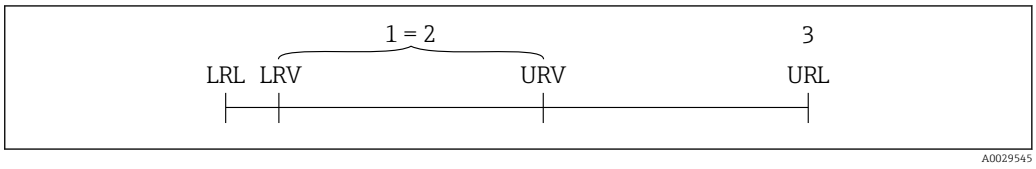
See the "Safety instructions" section → 113

Terms and abbreviations



Item	Term/abbreviation	Explanation
1	OPL	The OPL (over pressure limit = sensor overload limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. For the relevant standards and additional information, see the "Pressure specifications"→ 🖹 47 section. The OPL may only be applied for a limited period of time.
2	MWP	The MWP (maximum working pressure) for the sensors depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. For the relevant standards and additional information, see the "Pressure specifications"→ 🖹 47 section. The MWP may be applied at the device for an unlimited period. The MWP can also be found on the nameplate.
3	Maximum sensor measuring range	Span between LRL and URL This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
4	Calibrated/adjusted span	Span between LRV and URV Factory setting: 0 to URL Other calibrated spans can be ordered as customized spans.
p	-	Pressure
-	LRL	Lower range limit
-	URL	Upper range limit
-	LRV	Lower range value
-	URV	Upper range value
-	TD (turn down)	Turn down Example - see the following section.

Turn down calculation



1 Calibrated/adjusted span
2 Zero point-based span
3 URL sensor

Example

- Sensor:10 bar (150 psi)
- Upper range value (URL) = 10 bar (150 psi)
- Calibrated/adjusted span: 0 to 5 bar (0 to 75 psi)
- Lower range value (LRV) = 0 bar (0 psi)
- Upper range value (URV) = 5 bar (75 psi)

Turn down (TD):

$$TD = \frac{URL}{|URV - LRV|}$$

$$TD = \frac{10\ \text{bar (150 psi)}}{|5\ \text{bar (75 psi)} - 0\ \text{bar (0 psi)}|} = 2$$

In this example, the TD is 2:1.
This span is based on the zero point.

Registered trademarks

HART®

Registered trademark of the FieldComm Group, Austin, USA

PROFIBUS®

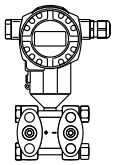
Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

FOUNDATION™Fieldbus

Registered trademark of the FieldComm Group, Austin, Texas, USA

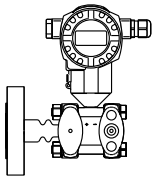
Function and system design

Device selection



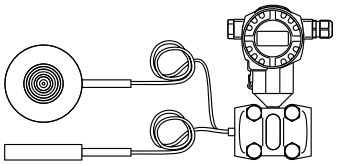
A0023922

PMD75



A0023923

FMD77 with mounted diaphragm seal



A0023924

FMD78 with capillary diaphragm seals

Field of application

PMD75:
- Flow
- Level
- Differential pressure
- Pressure

FMD77:
- Level
- Differential pressure

FMD78:
- Level
- Differential pressure

Process connections

PMD75:
- 1/4 – 18 NPT
- RC 1/4

FMD77 low-pressure side (–):
- 1/4 – 18 NPT
- RC 1/4
- Alternatively available with capillary and diaphragm seal

FMD77 high-pressure side (+):
- DN 50 – DN 100
- ASME NPS 2" – 4"
- JIS 80A – 100A

FMD78:
Wide range of diaphragm seals

Measuring ranges

- PMD75: from −10 to +10 mbar (-0.15 to +0.15 psi) to −40 to +40 bar (-600 to +600 psi)
  As gauge or absolute pressure sensor: up to 250 bar (3750 psi)
- FMD77: from −100 to +100 mbar (-1.5 to +1.5 psi) to −16 bar to +16 bar (-240 to +240 psi)
- FMD78: from −100 to +100 mbar (-1.5 to +1.5 psi) to −40 to +40 bar (-600 to +600 psi)

OPL

PMD75:
on one side: up to 420 bar (6 300 psi)
on both sides: up to 630 bar (9 450 psi)
As gauge or absolute pressure sensor: up to 375 bar (5625 psi)

FMD77:
on one side: up to 160 bar (2 400 psi)
on both sides: up to 240 bar (3 600 psi)

FMD78:
on one side: up to 160 bar (2 400 psi)
on both sides: up to 240 bar (3 600 psi)

Process temperature range(temperature at process connection)

PMD75:
−40 to +85 °C (−40 to +185 °F)

FMD77:
−70 to +400 °C (−94 to +752 °F)
(depending on the filling oil)

FMD78:
−70 to +400 °C (−94 to +752 °F)
(depending on the filling oil)

Ambient temperature range

- Without LCD display: −50 to +85 °C (−58 to +185 °F)
- With LCD display: −20 to +70 °C (−4 to +158 °F)
  (extended temperature application range−50 to +85 °C (−58 to +185 °F) with limitations in optical properties, such as display speed and contrast)
- Separate housing −20 to +60 °C (−4 to +140 °F):
- Diaphragm seal systems depending on the version

Reference accuracy

- PMD75: up to ±0.035 % of the set span
- FMD77: up to ±0.075 % of the set span
- FMD78: up to ±0.075 % of the set span

Supply voltage

Supply voltage non-Ex
- 4 to 20 mA HART: 10.5 to 45 V DC
- PROFIBUS PA and FOUNDATION Fieldbus: 9 to 32 V DC

Supply voltage Ex ia
10.5 to 30 V DC

Output

4 to 20 mA with superimposed HART protocol, PROFIBUS PA or FOUNDATION Fieldbus

Options

- HistoROM®/M-DAT memory chip
- PMD75: with blind flange on LP side for gauge and absolute pressure measurement

Specialties

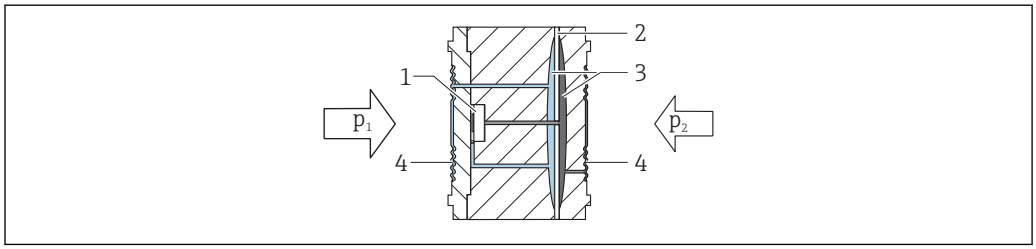
PMD75:
- p_{stat} up to 420 bar (6 300 psi)
- Process isolating diaphragm: tantalum

FMD77:
For extreme medium temperatures

FMD78:
Wide range of diaphragm seals

Measuring principle

Metal process isolating diaphragm



A0023919

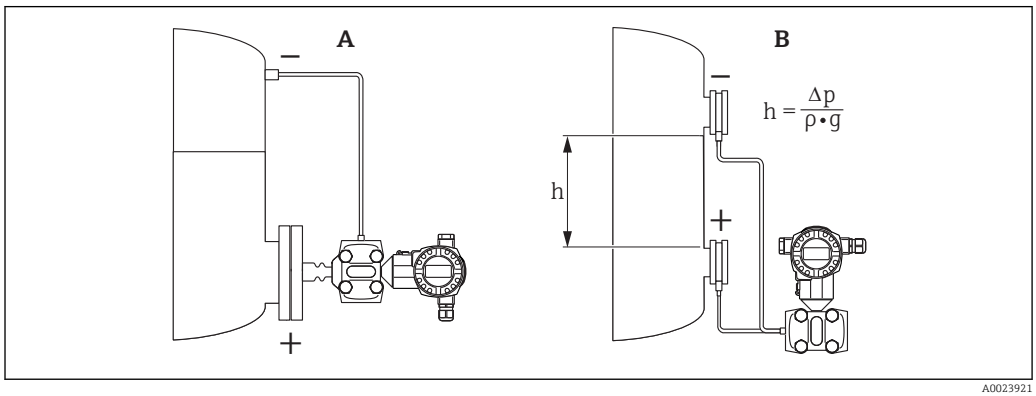
1 Measuring element
2 Middle diaphragm
3 Filling oil
4 Process isolating diaphragm

The process isolating diaphragms are deflected on both sides by the acting pressures. A filling oil transfers the pressure to a resistance bridge (semiconductor technology). The change in the bridge output voltage, which depends on the differential pressure, is measured and processed

Advantages:
- Standard system pressures: 160 bar (2 400 psi) up to 420 bar (6 300 psi)
- High long-term stability
- Very high single-sided overload resistance

Product design

Level measurement (level, volume and mass):



A0023921

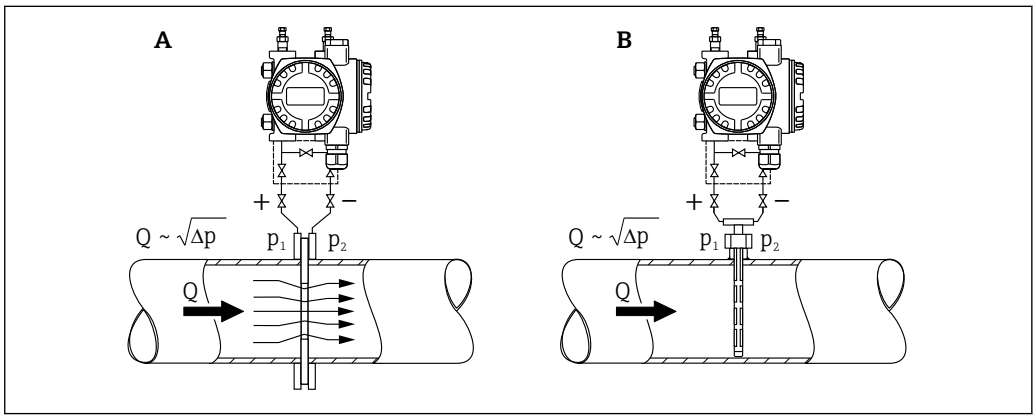
A Level measurement with FMD77
B Level measurement with FMD78
h Height (level)
Δp Differential pressure
ρ Density of the medium
g Gravitational constant

Your benefits

- Selection of the level operating mode which is optimum for your application in the device software
- Volume and mass measurements in any container shapes by means of a freely programmable characteristic curve
- Choice of diverse level units with automatic unit conversion
- A customized unit can be specified.
- Has a wide range of uses, e.g.
  - for level measurement in vessels with pressure overlay
  - in the event of foam formation
  - in containers with agitators or screen fittings
  - in the event of liquid gases
  - for standard level measurement

Flow measurement

Flow measurement with Deltabar S and primary device:



A Orifice plate
B Pitot tube
Q Flow
Δp Differential pressure, $\Delta p = p_1 - p_2$

Your benefits

- Choice of four flow modes of operation: volume flow, corrected volume flow (European norm conditions), standard volume flow (American standard conditions) and mass flow
- Choice of diverse flow units with automatic unit conversion
- A customized unit can be specified.
- Low flow cut off: when activated, this function suppresses small flows which can lead to large fluctuations in the measured value.
- Contains two totalizers as standard. One totalizer can be reset to zero.
- The totalizing mode and unit can be individually set for each totalizer. This allows independent daily and annual quantity totalizing.

Communication protocol

- 4 to 20 mA with HART communication protocol
- PROFIBUS PA
  - The Endress+Hauser devices meet the requirements of the FISCO model.
  - Due to a low current consumption of 13 mA ± 1 mA, the following number of devices can be operated on one bus segment if installing as per FISCO: up to 7 devices for Ex ia, CSA IS and FM IS applications or up to 27 devices for all other applications e.g. in non-hazardous areas, Ex nA etc. Further information on PROFIBUS PA can be found in Operating Instructions BA00034S "PROFIBUS DP/PA: Guidelines for planning and commissioning" and in the PNO Guideline.
- FOUNDATION Fieldbus
  - The Endress+Hauser devices meet the requirements of the FISCO model.
  - Due to a low current consumption of 15.5 mA ± 1 mA, the following number of devices can be operated on one bus segment if installing as per FISCO: up to 6 devices for Ex ia, CSA IS and FM IS applications or up to 24 devices for all other applications e.g. in non-hazardous areas, Ex nA etc. Further information on FOUNDATION Fieldbus, such as requirements for bus system components, can be found in Operating Instructions BA00013S "FOUNDATION Fieldbus Overview".

Input

Measured variable

Measured process variables

Differential pressure, pressure

Calculated process variables

- Flow rate (volume flow or mass flow)
- Absolute pressure, gauge pressure
- Level (level, volume or mass)

Measuring range

Sensor	Maximum sensor measuring range		Smallest calibratable span [1]	MWP	OPL		remains stable for a minimum of operating pressure [2]	Option [3]
	lower (LRL)	upper (URL)			on one side	on both sides		PN 160
[mbar (psi)]	[mbar (psi)]	[mbar (psi)]	[mbar (psi)]	[bar (psi)]	[bar (psi)]	[bar (psi)]	[$mbar_{abs}$ (psi_{abs})]	
FMD77, FMD78, PMD75: Option PN 160 / 16 MPa / 2400 psi								
10 (0.15) (PMD75 only)	–10 (-0.15)	+10 (+0.15)	0.25 (0.00375)	160 (2400)	160 (2400)	240 (3600)	0.1 (0.0015)	7B
30 (0.45) (PMD75 only)	–30 (-0.45)	+30 (+0.45)	0.3 (0.0045)					7C
100 (1.5)	–100 (-1.5)	+100 (+1.5)	1/5 (0.015/0.075) [4]	160 (2400) [5]				7D
500 (7.5)	–500 (-7.5)	+500 (+7.5)	5 (0.075)					7F
3000 (45)	–3000 (-45)	+3000 (+45)	30 (0.45)					7H
16000 (240)	–16000 (-240)	+16000 (+240)	160 (2.4)					7L
40000 (600)	–40000 (-600)	+40000 (+600)	400 (6)		"+" side [6]: 160 (2400)			7M
PMD75: Option PN 420 / 42 MPa / 6300 psi								
100 (1.5)	–100 (-1.5)	+100 (+1.5)	1/5 (0.015/0.075) [4]	420 (6300) [5]	420 (6300)	630 (9450)	0.1 (0.0015)	8D
500 (7.5)	–500 (-7.5)	+500 (+7.5)	5 (0.075)					8F
3000 (45)	–3000 (-45)	+3000 (+45)	30 (0.45)					8H
16000 (240)	–16000 (-240)	+16000 (+240)	160 (2.4)					8L
40000 (600)	–40000 (-600)	+40000 (+600)	400 (6)		"+" side [6]: 420 (6300)			8M

1) Turn down > 100:1 on request
2) The minimum operating pressure indicated in the table applies to silicone oil under reference operating conditions. Min. operating pressure at 85 °C (185 °F) for silicone oil: up to 10 $mbar_{abs}$ (0.15 psi_{abs}). FMD77 and FMD78: Min. operating pressure: 50 $mbar_{abs}$ (0.75 psi_{abs}); observe also the pressure and temperature application limits of the selected filling oil → 🖹 97. For vacuum applications, follow the installation instructions→ 🖹 102.
3) Product Configurator, order code for "Nominal range; PN"
4) Smallest calibratable span for the PMD75: 1 mbar (0.015 psi); Smallest calibratable span for the FMD77 and FMD78: 5 mbar (0.075 psi)
5) All PMD75 process connections are CRN-approved. If O-rings are used, the MWP is 315 bar (4 725 psi); if PTFE and CU seals are used, the MWP is 120 bar (1 800 psi).
6) "–" side: 100 bar (1 500 psi)

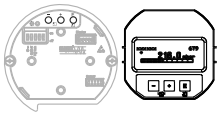
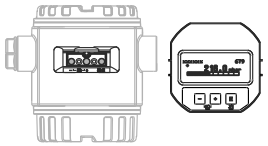
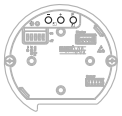
Sensor	Maximum sensor measuring range		Smallest calibratable span	MWP	OPL		remains stable for a minimum of operating pressure [1]	Option [2]
	lower (LRL)	upper (URL)			on one side	on both sides		
bar (psi)	bar (psi)	bar (psi)	bar (psi)	bar (psi)	bar (psi)		$mbar_{abs}$ (psi_{abs})	
PMD75: optionally available as a gauge or absolute pressure sensor								
160 (2400) rel	-1 (-15)	160 (2400)	40 (600)	160 (2400)	240 (3600)	- [3]	10	7Q
160 (2400) abs	0	160 (2400)	4 (60)	160 (2400)	240 (3600)	- [3]	10	7V
250 (3750) rel	-1 (-15)	250 (3750)	40 (600)	250 (3750)	375 (5625)	- [3]	10	7R
250 (3750) abs	0	250 (3750)	4 (60)	250 (3750)	375 (5625)	- [3]	10	7W

1) The minimum operating pressure indicated in the table applies to silicone oil under reference operating conditions. Min. operating pressure at 85 °C (185 °F) for silicone oil: up to 10 $mbar_{abs}$ (0.15 psi_{abs}).
2) Product Configurator, order code for "Nominal range; PN"
3) Available only with blind flange on LP side.

Output

Output Signal

- 4 to 20 mA with superimposed digital communication protocol HART, 2-wire
- Digital communication signal PROFIBUS PA (Profile 3.0), 2-wire
  - Signal coding: Manchester Bus Powered (MBP): Manchester II
  - Transmission rate: 31.25 KBit/s voltage mode
- Digital communication signal FOUNDATION Fieldbus, 2-wire
  - Signal coding: Manchester Bus Powered (MBP): Manchester II
  - Transmission rate: 31.25 KBit/s voltage mode

Output	Internal + LCD	External + LCD	Internal
	   A0021280		
	Option [1]		
4 to 20mA HART	B	A	C
4 to 20mA HART, Li=0	E	D	F
PROFIBUS PA	N	M	O
FOUNDATION Fieldbus	Q	P	R

1) Product Configurator, order code for "Display, operation: "

Signal range

4 to 20 mA

3.8 mA to 20.5 mA

Signal on alarm

4 to 20 mA HART

As per NAMUR NE43.

- Max. alarm: can be set from 21 to 23 mA (factory setting: 22 mA)
- Hold measured value: last measured value is held
- Min. alarm: 3.6 mA

PROFIBUS PA

As per NAMUR NE43.

Can be set in the Analog Input Block.

Options:
- Last Valid Out Value (factory setting)
- Fail Safe Value
- Status bad

FOUNDATION Fieldbus

As per NAMUR NE43.

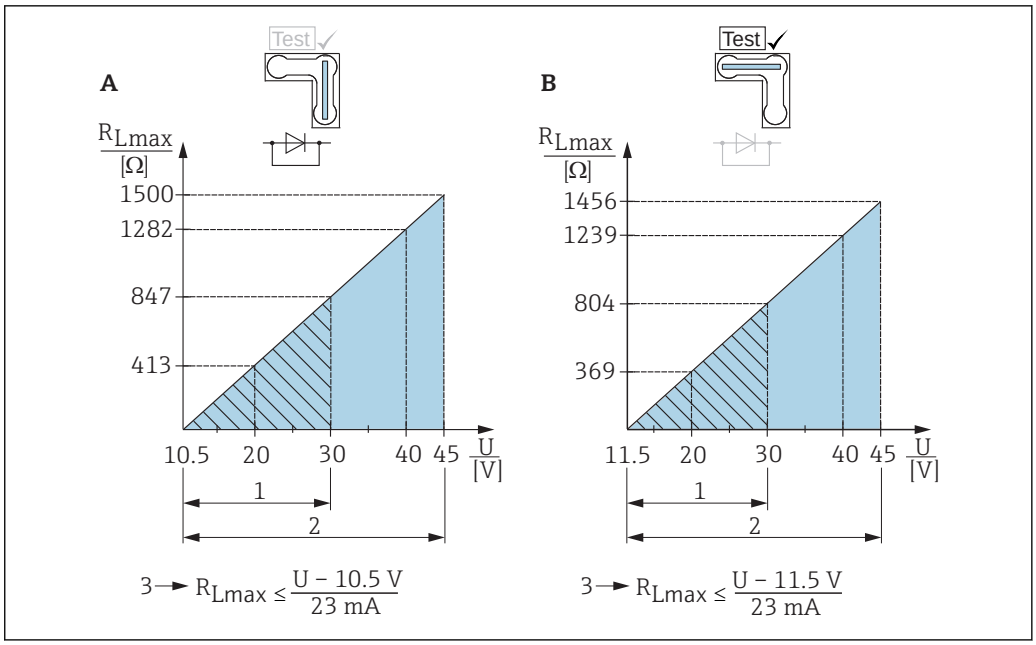
Can be set in the Analog Input Block.

Options:
- Last Good Value
- Fail Safe Value (factory setting)
- Wrong Value

Load

4 to 20 mA HART

In order to guarantee sufficient terminal voltage in two-wire devices, a maximum load resistance R (including line resistance) must not be exceeded depending on the supply voltage U_0 of the supply unit. In the following load diagrams, observe the position of the jumper and the explosion protection:



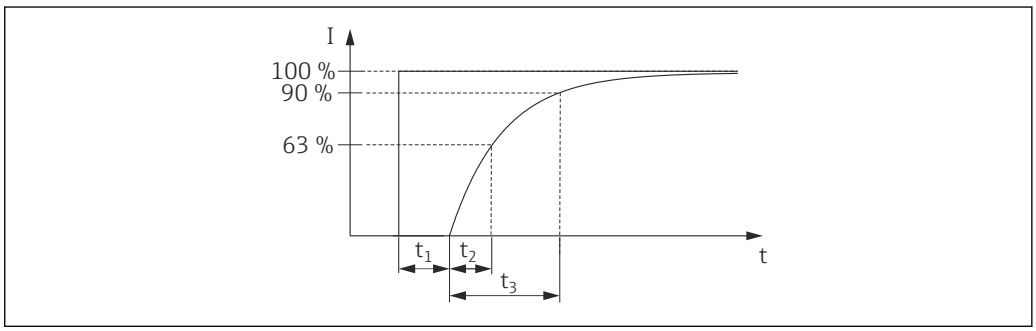
A0019988

A Jumper for 4 to 20 mA test signal set to "Non-test" position
B Jumper for 4 to 20 mA test signal set to "Test" position
1 Power supply 10.5 (11.5) to 30 V DC for 1/2 G Ex ia, 1GD Ex ia, 1/2 GD Ex ia, FM IS, CSA IS, IECEx ia, NEPSI Ex ia
2 Power supply 10.5 (11.5) to 45 V DC for devices for non-hazardous areas, 1/2 D, 1/3 D, 2 G Ex d, 3 G Ex nA, FM XP, FM DIP, FM NI, CSA XP, CSA dust ignition-proof, NEPSI Ex d
3 R_{Lmax} maximum load resistance
U Supply voltage

When operating via a handheld terminal or via a PC with an operating program, a minimum communication resistance of 250 Ω must be taken into account.

Dead time, time constant

Presentation of the dead time and the time constant:



A0019786

Dynamic behavior, current output

Type		Measuring cell	Dead time (t_1) [ms]	Time constant T63 (t_2) [ms]	Time constant T90 (t_3) [ms]
PMD75	max.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi)	45	▪ 450 ▪ 450 ▪ 60 ▪ 45 ▪ 40 ▪ 60 ▪ 60	▪ 1040 ▪ 1040 ▪ 138 ▪ 104 ▪ 92 ▪ 138 ▪ 138
		▪ 160 bar (2 400 psi) ▪ 250 bar (3 750 psi)	50	40	90
FMD77, FMD78	max.	Dependent on the diaphragm seal			

Dynamic behavior Digital output (HART electronics)

A typical burst rate of 300 ms results in the following behavior:

Type		Measuring cell	Dead time (t_1) [ms]	Dead time (t_1) [ms] + Time constant T63 (t_2) [ms]	Dead time (t_1) [ms] + Time constant T90 (t_3) [ms]
PMD75	min.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi) ▪ 160 bar (2 400 psi) ▪ 250 bar (3 750 psi)	205	▪ 655 ▪ 655 ▪ 265 ▪ 250 ▪ 245 ▪ 265 ▪ 265 ▪ 295 ▪ 295	▪ 1200 ▪ 1200 ▪ 298 ▪ 264 ▪ 252 ▪ 298 ▪ 298 ▪ 300 ▪ 300
	max.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi) ▪ 160 bar (2 400 psi) ▪ 250 bar (3 750 psi)	1005	▪ 1455 ▪ 1455 ▪ 1065 ▪ 1050 ▪ 1045 ▪ 1065 ▪ 1065 ▪ 1095 ▪ 1095	▪ 2000 ▪ 2000 ▪ 1098 ▪ 1064 ▪ 1052 ▪ 1098 ▪ 1098 ▪ 1100 ▪ 1100
FMD77, FMD78	max.	Dependent on the diaphragm seal			

Reading cycle

- Acyclic: max. 3/s, typically 1/s (depending on command # and number of preambles)
- Cyclic (burst): max. 3/s, typically 2/s

The device commands the BURST MODE functionality for cyclical value transmission via the HART communication protocol.

Cycle time (update time)

Cyclic (burst): min. 300 ms

Response time

- Acyclic: min. 330 ms, typically 590 ms (depending on command # and number of preambles)
- Cyclic (burst): min. 160 ms, typically 350 ms (depending on command # and number of preambles)

Dynamic behavior PROFIBUS PA

A typical PLC cycle time of 1 s results in the following behavior:

Type		Measuring cell	Dead time (t_1) [ms]	Dead time (t_1) [ms] + Time constant T63 (t_2) [ms]	Dead time (t_1) [ms] + Time constant T90 (t_3) [ms]
PMD75	min.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi)	80	▪ 530 ▪ 530 ▪ 140 ▪ 125 ▪ 120 ▪ 140 ▪ 140	▪ 1075 ▪ 1075 ▪ 173 ▪ 139 ▪ 127 ▪ 173 ▪ 173
	max.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi)	1280	▪ 1730 ▪ 1730 ▪ 1340 ▪ 1325 ▪ 1320 ▪ 1340 ▪ 1340	▪ 2275 ▪ 2275 ▪ 1373 ▪ 1339 ▪ 1327 ▪ 1373 ▪ 1373
FMD77, FMD78	max.	Dependent on the diaphragm seal			

Reading cycle (PLC)

- Acyclic: Typically 25/s
- Cyclic: Typically 30/s (depending on the number and type of the function blocks used in the closed-control loop)

Cycle time (update time)

min. 200 ms

The cycle time in a bus segment in cyclic data communication depends on the number of devices, on the segment coupler used and on the internal PLC cycle time. A new measured value can be determined up to five times a second.

Response time

- Acyclic: Approx. 60 ms to 70 ms (depending on Min. Slave Interval)
- Cyclic: Approx. 10 ms to 13 ms (depending on Min. Slave Interval)

Dynamic behavior FOUNDATION Fieldbus

A typical configuration for the macro cycle time (host system) of 1 s results in the following behavior:

Type		Measuring cell	Dead time (t_1) [ms]	Dead time (t_1) [ms] + Time constant T63 (t_2) [ms]	Dead time (t_1) [ms] + Time constant T90 (t_3) [ms]
PMD75	min.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi)	90	▪ 540 ▪ 540 ▪ 150 ▪ 135 ▪ 130 ▪ 150 ▪ 150	▪ 1085 ▪ 1085 ▪ 183 ▪ 149 ▪ 137 ▪ 183 ▪ 183
	max.	▪ 10 mbar (0.15 psi) ▪ 30 mbar (0.45 psi) ▪ 100 mbar (1.5 psi) ▪ 500 mbar (7.5 psi) ▪ 3 bar (45 psi) ▪ 16 bar (240 psi) ▪ 40 bar (600 psi)	1090	▪ 1540 ▪ 1540 ▪ 1150 ▪ 1135 ▪ 1130 ▪ 1150 ▪ 1150	▪ 2085 ▪ 2085 ▪ 1183 ▪ 1149 ▪ 1137 ▪ 1183 ▪ 1183
FMD77, FMD78	max.	Dependent on the diaphragm seal			

Reading cycle

- Acyclic: Typically 10/s
- Cyclic: max. 10/s (dependent on the number and type of function blocks used in a closed-control loop)

Cycle time (update time)

Cyclic: Min. 100 ms

Response time

- Acyclic: Typically 100 ms (for standard bus parameter settings)
- Cyclic: max. 20 ms (for standard bus parameter settings)

Damping

A damping affects all outputs (output signal, display):
- via local display, handheld terminal or PC with operating program, continuous from 0 to 999 s
- Also for HART and PROFIBUS PA: Via DIP switch on the electronic insert, switch position "on" = set value and "off"
- Factory setting: 2 s

Alarm current

Designation	Option [1]
Min alarm current	J
HART burst mode PV	J
Min alarm current + HART burst mode PV	J

1) Product Configurator, "Additional options 1" and "Additional options 2" ordering feature

Firmware version

Designation	Option [1]
02.20.zz, HART 7, DevRev22	72
02.11.zz, HART 5, DevRev21	73
04.00.zz, FF, DevRev07	74
04.01.zz, PROFIBUS PA, DevRev03	75
02.10.zz, HART 5, DevRev21	76
03.00.zz, FF, DevRev06	77
04.00.zz, PROFIBUS PA	78
02.30.zz, HART 7	In preparation

1) Product Configurator, order code for "Firmware version"

HART protocol-specific data

Manufacturer ID	17 (11 hex)
Device type code	23 (17 hex)
Device revision	▪ 21 (15 hex) - SW version 02.1y.zz - HART specification 5 ▪ 22 (16 hex) - SW version 02.2y.zz - HART specification 7
HART specification	▪ 5 ▪ 7
DD revision	▪ 4 (Russian in language selection) for device revision 21 ▪ 3 (Dutch in language selection) for device revision 21 ▪ 1 for device revision 22
Device description files (DTM, DD)	Information and files at: ▪ www.endress.com ▪ www.fieldcommgroup.org
HART load	Min. 250 Ω

HART device variables	The measured values are assigned to the device variables as follows: **Measured values for PV (primary variable)** ▪ Pressure ▪ Flow ▪ Level ▪ Tank content **Measured values for SV, TV (second and third variable)** ▪ Pressure ▪ Totalizer **Measured values for QV (fourth variable)** Temperature
Supported functions	▪ Burst mode ▪ Additional transmitter status ▪ Device locking ▪ Alternative operating modes

PROFIBUS PA protocol-specific data

Manufacturer ID	17 (11 hex)
Identification number	1542 hex
Profile version	3.0 ▪ SW version 03.00.zz ▪ SW version 04.00.zz 3.02 SW version 04.01.zz (device revision 3) Compatibility with SW version 03.00.zz and higher.
GSD revision	▪ 4 (SW version 3.00.zz and 4.00.zz) ▪ 5 (device revision 3)
DD revision	▪ 1 (SW version 3.00.zz and 4.00.zz) ▪ 1 (device revision 3)
GSD file	Information and files at: ▪ www.endress.com ▪ www.profibus.org
DD files	
Output values	**Measured value for PV (via Analog Input Function Block)** ▪ Pressure ▪ Level ▪ Flow ▪ Tank content **Measured value for SV** ▪ Pressure ▪ Temperature **Measured value for QV** Totalizer
Input values	Input value sent from PLC, can be shown on display
Supported functions	▪ Identification & maintenance Simplest device identifier on the control system and nameplate ▪ Condensed status (only with Profile Version 3.02) ▪ Automatic ID number adjustment and switchable to the following ID numbers (only with Profile Version 3.02): – 9700: Profile-specific transmitter identification number with the "Classic" or "Condensed" status". – 1504: Compatibility mode for the old Deltabar S generation (FMD230, FMD630, FMD633, PMD230, PMD235). – 1542: Identification number of the new Deltabar S generation (FMD77, FMD78, PMD75). ▪ Device locking: The device can be locked by hardware or software.

FOUNDATION Fieldbus protocol-specific data

Manufacturer ID	452B48 hex
Device type	1009 hex
Device revision	▪ 6 - SW version 03.00.zz ▪ 7 - SW version 04.00.zz (FF-912)

DD revision	▪ 3 (device revision 6) ▪ 2 (device revision 7)
CFF revision	▪ 4 (device revision 6) ▪ 1 (device revision 7)
DD files	Information and files at: ▪ www.endress.com ▪ www.fieldcommgroup.org
CFF files	
Device tester version (ITK version)	▪ 5.0 (device revision 6) ▪ 6.01 (device revision 7)
Number of ITK test campaign	▪ IT054700 (Device Revision 6) ▪ IT085400 (Device Revision 7)
Link Master (LAS) capable	Yes
Choice of "Link Master" and "Basic Device"	Yes, factory setting is Basic Device
Node address	Factory setting: 247 (F7 hex)
Supported functions	Field diagnostics profile (only with FF912) The following methods are supported: ▪ Restart ▪ Configure error as warning or alarm ▪ HistoROM ▪ Peakhold ▪ Alarm info ▪ Sensor trim
Number of VCRs	▪ 44 (device revision 6) ▪ 24 (device revision 7)
Number of link objects in VFD	50

Virtual communication references (VCRs)

	Device revision 6	Device revision 7
Permanent entries	44	1
Client VCRs	0	0
Server VCRs	5	10
Source VCRs	8	43
Sink VCRs	0	0
Subscriber VCRs	12	43
Publisher VCRs	19	43

Link settings

	Device revision 6	Device revision 7
Slot time	4	4
Min. Inter PDU delay	12	10
Max. response delay	10	10

Transducer Blocks

Block	Content	Output values
TRD1 Block	Contains all parameters related to the measurement	▪ Pressure, flow or level (channel 1) ▪ Process temperature (channel 2)
Service Block	Contains service information	▪ Pressure after damping (channel 3) ▪ Pressure peakhold indicator (channel 4) ▪ Counter for max. pressure transgressions (channel 5)
Dp Flow Block	Contains flow and totalizer parameter	Totalizer 1 (channel 6)
Diagnostic Block	Contains diagnostic information	Error code via DI channels (channel 0 to 16)
Display Block	Contains parameters to configure the onsite display	No output values

Function blocks

Block	Content	Number blocks	Execution time		Functionality	
			Device Revision 6	Device Revision 7	Device Revision 6	Device Revision 7
Resource Block	This block contains all the data that uniquely identifies the device; it is an electronic version of a nameplate for the device.	1			enhanced	enhanced
Analog Input Block 1 Analog Input Block 2 Analog Input Block 3	The AI Block receives the measuring data from the Sensor Block, (selectable via a channel number) and makes the data available to other function blocks at its output. Enhancement: Digital outputs for process alarms, fail safe mode	3	45 ms	45 ms (without trend and alarm reports)	enhanced	enhanced
Digital Input Block	This block contains the discrete data of the Diagnose Block (selectable via a channel number 0 to 16) and provides them for other blocks at the output.	1	40 ms	30 ms	standard	enhanced
Digital Output Block	This block converts the discrete input and thus initiates an action (selectable via a channel number) in the DP Flow Block or in the Service Block. Channel 1 resets the counter for max. pressure transgressions.	1	60 ms	40 ms	standard	enhanced
PID Block	This block is used as a proportional-integral-derivative controller and can be used universally for closed-loop-control in the field. It enables cascade mode and feedforward control. Input IN can be indicated on the display. The selection is performed in the Display Block (DISPLAY_MAIN_LINE_CONTENT).	1	120 ms	70 ms	standard	enhanced
Arithmetic Block	This block is designed to permit simple use of popular measurement math functions. The user does not have to know how to write equations. The math algorithm is selected by name, chosen by the user for the function to be performed.	1	50 ms	40 ms	standard	enhanced
Input Selector Block	The Input Selector Block facilitates the selection of up to four inputs and generates an output based on the configured action. This block normally receives its inputs from AI Blocks. The block performs maximum, minimum, average and 'first good' signal selection. Inputs IN1 to IN4 can be indicated on the display. The selection is performed in the Display Block (DISPLAY_MAIN_LINE_CONTENT).	1	35 ms	35 ms	standard	enhanced
Signal Characterizer Block	The Signal Characterizer Block has two sections, each with an output that is a non-linear function of the respective input. The non-linear function is generated by a single look-up table with 21 arbitrary x-y pairs.	1	30 ms	40 ms	standard	enhanced

Block	Content	Number blocks	Execution time		Functionality	
			Device Revision 6	Device Revision 7	Device Revision 6	Device Revision 7
Integrator Block	The Integrator Block integrates a variable as a function of the time or accumulates the counts from a Pulse Input Block. The block can be used as a totalizer that counts up until a reset, or as a batch totalizer whereby the integrated value is compared against a target value generated before or during the control routine and generates a binary signal when the target value is reached.	1	35 ms	40 ms	standard	enhanced
Analog Alarm Block	This block contains all process alarm conditions (working like a comparator) and represents them at the output.	1	35 ms	35 ms	standard	enhanced

Additional function block information:

Instantiatable function blocks	YES	YES
Number of additional instantiatable function blocks	9	4

Power supply

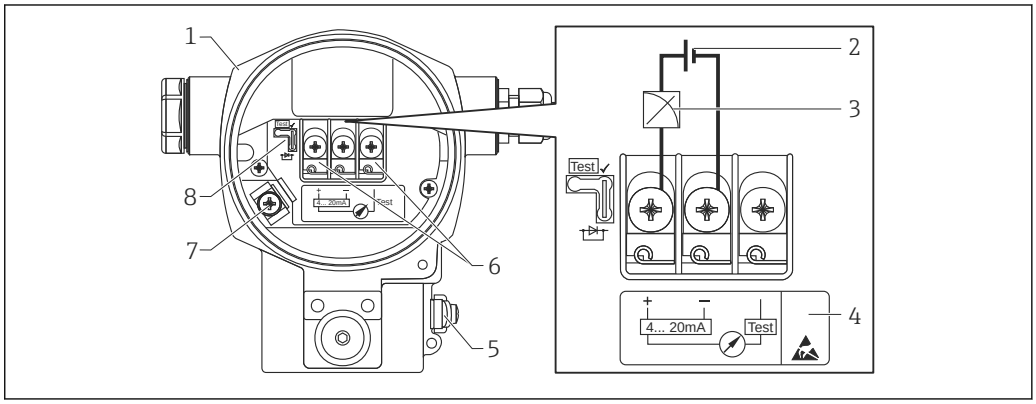
⚠ WARNING

Electrical safety is compromised by an incorrect connection!

- When using the measuring device in hazardous areas, the relevant national standards and regulations as well as the Safety Instructions or Installation or Control Drawings must also be observed.→ 113.
- All explosion protection data are given in separate documentation which is available upon request. The Ex documentation is supplied as standard with all Ex devices→ 113.
- Devices with integrated overvoltage protection must be grounded→ 26.
- Protective circuits against reverse polarity, HF influences and overvoltage peaks are integrated.

Terminal assignment

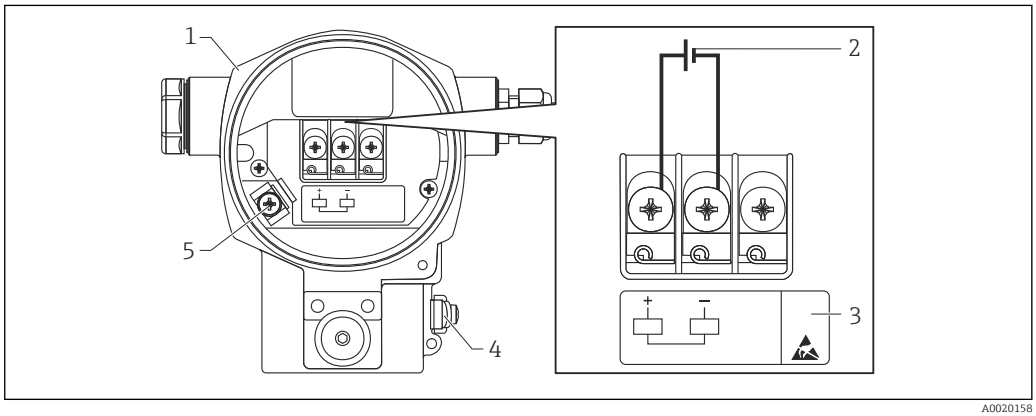
4 to 20 mA HART



A0019989

1 *Housing*
2 *Supply voltage*
3 *4 to 20 mA*
4 *Devices with integrated overvoltage protection are labeled "OVP" (overvoltage protection) here.*
5 *External ground terminal*
6 *4 to 20 mA test signal between positive and test terminal*
7 *Internal ground terminal*
8 *Jumper for 4 to 20 mA test signal*

PROFIBUS PA and FOUNDATION Fieldbus



A0020158

1 *Housing*
2 *Supply voltage*
3 *Devices with integrated overvoltage protection are labeled "OVP" (overvoltage protection) here.*
4 *External ground terminal*
5 *Internal ground terminal*

Supply voltage

4 to 20 mA HART

Electronic version	Jumper for 4 to 20 mA test signal in "Test" position (delivery status)	Jumper for 4 to 20 mA test signal in "Non-test" position
Version for non-hazardous area	11.5 to 45 V DC	10.5 to 45 V DC
Intrinsically safe	11.5 to 30 V DC	10.5 to 30 V DC
▪ Other types of protection ▪ Devices without certificate	11.5 to 45 V DC (versions with 35 V DC plug-in connection)	10.5 to 45 V DC (versions with 35 V DC plug-in connection)

Measuring a 4 to 20 mA test signal

Jumper position for test signal	Description
 A0019992	▪ Measurement of 4 to 20 mA test signal via the positive and test terminal: Possible. (Thus, the output current can be measured without interruption via the diode.) ▪ Delivery status ▪ Minimum supply voltage: 11.5 V DC
 A0019993	▪ Measurement of 4 to 20 mA test signal via positive and test terminal: Not possible. ▪ Minimum supply voltage: 10.5 V DC

PROFIBUS PA

- Version for non-hazardous areas: 9 to 32 V DC
- Ex ia: 10.5 to 30 V DC

FOUNDATION Fieldbus

- Version for non-hazardous areas: 9 to 32 V DC
- Ex ia: 10.5 to 30 V DC

Current consumption

- PROFIBUS PA: 13 mA ±1 mA, switch-on current corresponds to IEC 61158-2, Clause 21
- FOUNDATION Fieldbus: 15.5 mA ±1 mA, switch-on current corresponds to IEC 61158-2, Clause 21

Electrical connection

PROFIBUS PA

The digital communication signal is transmitted to the bus via a two-wire connection. The bus also provides the power supply. For further information on the network structure and grounding, and for further bus system components such as bus cables, see the relevant documentation, e.g. Operating Instructions BA00034S "PROFIBUS DP/PA: Guidelines for planning and commissioning" and the PNO Guideline.

FOUNDATION Fieldbus

The digital communication signal is transmitted to the bus via a two-wire connection. The bus also provides the power supply. For further information on the network structure and grounding and for further bus system components such as bus cables, see the relevant documentation, e.g. Operating Instructions BA00013S "FOUNDATION Fieldbus Overview" and the FOUNDATION Fieldbus Guideline.

Terminals

- Supply voltage and internal ground terminal: 0.5 to 2.5 mm^2 (20 to 14 AWG)
- External ground terminal: 0.5 to 4 mm^2 (20 to 12 AWG)

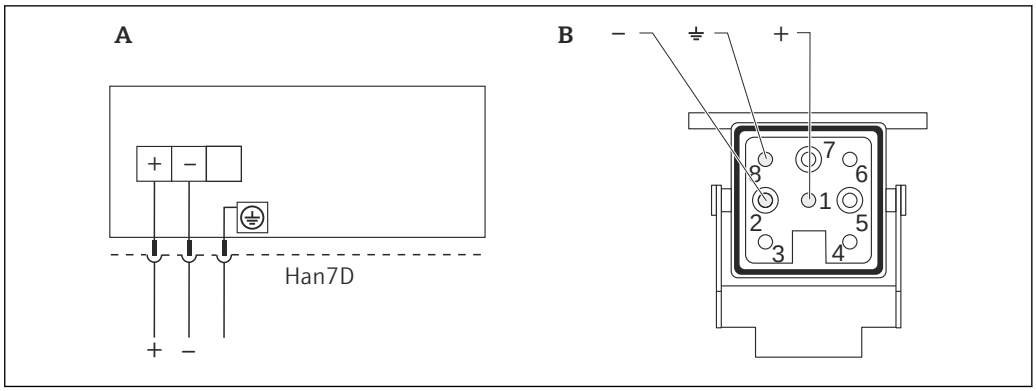
Cable entries

Approval	Cable gland	Clamping area
Standard, II 1/2 G Ex ia, IS	Plastic M20x1.5	5 to 10 mm (0.2 to 0.39 in)
ATEX II 1/2 D, II 1/3 D, II 1/2 GD Ex ia, II 1 GD Ex ia, II 3 G Ex nA	Metal M20x1.5 (Ex e)	7 to 10.5 mm (0.28 to 0.41 in)

For additional technical data, see section on housing → 📄 49

Device plug

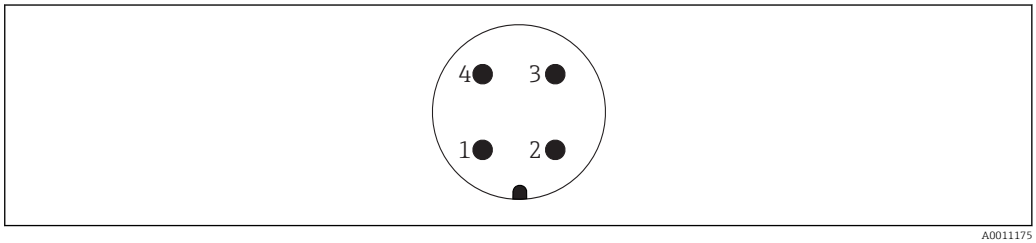
Devices with Harting plug Han7D



A Electrical connection for devices with Harting plug Han7D
B View of the plug-in connection on the device

Material: CuZn, gold-plated plug-in jack and plug

Devices with M12 plug



1 Signal +
2 Not assigned
3 Signal –
4 Ground

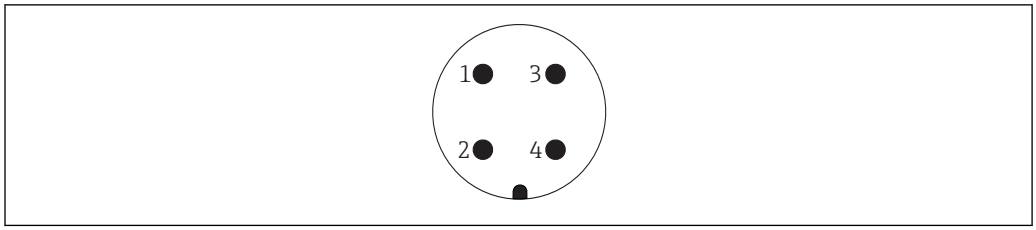
Endress+Hauser offers the following accessories for devices with an M12 plug:

Plug-in jack M 12x1, straight
- Material: Body PA; coupling nut CuZn, nickel-plated
- Degree of protection (fully locked): IP67
- Order number: 52006263

Plug-in jack M 12x1, elbowed
- Material: Body PBT/PA; coupling nut GD-Zn, nickel-plated
- Degree of protection (fully locked): IP67
- Order number: 71114212

Cable 4x0.34 mm^2 (20 AWG) with M12 socket, elbowed, screw plug, length 5 m (16 ft)
- Material: Body PUR; coupling nut CuSn/Ni; cable PVC
- Degree of protection (fully locked): IP67
- Order number: 52010285

Devices with 7/8" plug



A0011176

1 Signal –
2 Signal +
3 Not assigned
4 Shielding

External thread: 7/8 - 16 UNC
- Material: 316L (1.4401)
- Degree of protection: IP68

Cable specification

HART

- Endress+Hauser recommends using shielded, twisted-pair two-wire cables.
- Cable outer diameter: 5 to 9 mm (0.2 to 0.35 in) depending on the cable entry used → 📄 25

PROFIBUS PA

Use a twisted, shielded twin-core cable, preferably cable type A.

For further information regarding cable specifications, see the Operating Instructions BA00034S "PROFIBUS DP/PA: Guidelines for planning and commissioning", the PNO guideline 2.092 "PROFIBUS PA User and Installation Guideline" and IEC 61158-2 (MBP).

FOUNDATION Fieldbus

Use a twisted, shielded twin-core cable, preferably cable type A.

For further information on the cable specifications, see Operating Instructions BA00013S "FOUNDATION Fieldbus Overview", FOUNDATION Fieldbus Guideline and IEC 61158-2 (MBP).

Start-up current

12 mA

Residual ripple

Without influence on 4 to 20 mA signal up to ±5% residual ripple within the permitted voltage range [according to HART hardware specification HCF_SPEC-54 (DIN IEC 60381-1)].

Overvoltage protection (optionally for HART, PROFIBUS PA and FOUNDATION Fieldbus)

- Overvoltage protection:
  - Nominal functioning DC voltage: 600 V
  - Nominal discharge current: 10 kA
- Surge current check î = 20 kA satisfied as per DIN EN 60079-14: 8/20 µs
- Arrester AC current check I = 10 A satisfied

Ordering information: Product Configurator, order code for "Additional options 1" or Additional options 2", option "M"

NOTICE

Device could be destroyed!

► Devices with integrated overvoltage protection must be grounded.

Influence of power supply

≤0.0006 % of URL/1 V

Performance characteristics of differential pressure / pressure transmitter (sensor module + electronics module)

Preamble

The performance characteristic of the dP transmitter refers to "Accuracy of the transmitter". The factors influencing accuracy can be divided into two groups
- Total performance of transmitter → 🖹 28
- Installation dependent influencing factors → 🖹 36

Total performance of transmitter

Transmitter→ 🖹 28 total performance comprises the reference accuracy, the ambient temperature effect and the static pressure and is calculated using the following formula:

Total performance	=	$\pm \sqrt{ (E1)^2 + (E2)^2 + (E3)^2 }$
E1	=	Reference accuracy → 🖹 27
E2	=	Ambient temperature effect per ±28 °C (50 °F) (corresponds to the range of −3 to +53 °C (+27 to +127 °F)) → 🖹 30
E3	=	Static pressure effect → 🖹 31

Reference accuracy [E1]

PMD75: Reference accuracy E1 as % [1] The specifications refer to the calibrated span/Upper Range Value (URV).		
Measuring cell	**Standard**	**Platinum**
10 mbar (0.15 psi)	▪ TD 1:1 = ±0.075 ▪ TD > 1:1 = ±0.075 · TD	▪ TD 1:1 = ±0.05 ▪ TD > 1:1 = ±0.075 · TD
30 mbar (0.45 psi)	▪ TD ≤ 3:1 = ±0.075 ▪ TD > 3:1 = ±0.025 · TD	▪ TD 1:1 = ±0.05 ▪ TD > 1:1 to TD ≤ 3:1 = ±0.075 ▪ TD > 3:1 ±0.025 · TD
100 mbar (1.5 psi)	▪ TD ≤ 5:1 = ±0.05 ▪ TD > 5:1 = ±|0.009 · TD + 0.005|	TD ≥ 1:1 = ±0.04
500 mbar (7.5 psi), 3 bar (45 psi) 16 bar (240 psi), 40 bar (600 psi)	▪ TD ≤ 15:1 = ±0.05 ▪ TD > 15:1 = ±|0.0015 · TD + 0.0275|	TD ≥ 1:1 = ±0.035
160 bar (2 400 psi) rel/abs , 250 bar (3 750 psi) rel/abs	▪ TD ≤ 5:1 = ±0.10 ▪ TD > 5:1 = ±0.02 · TD	-

1) Reference accuracy comprises the non-linearity [DIN EN 61298-2] including the hysteresis [DIN EN 61298-2] and the non-repeatability [DIN EN 61298-2] in accordance with the limit point method as per [DIN EN 60770]. Reference accuracy for standard up to TD 100:1, for platinum up to TD 5:1. Valid for all membrane materials.

FMD77/FMD78: Reference accuracy as % [1] The specifications refer to the calibrated span / upper range value (URV) [2].		
Measuring cell	**FMD77**	**FMD77 with capillary on low-pressure side and FMD78**
100 mbar (1.5 psi)	▪ TD ≤ 5:1 = ±0.10 ▪ TD > 5:1 = ±0.02 · TD	▪ TD ≤ 5:1 = ±0.15 ▪ TD > 5:1 = ±0.03 · TD
500 mbar (7.5 psi)	▪ TD ≤ 15:1 = ±0.075 ▪ TD > 15:1 = ±[0.0015 · TD + 0.053]	▪ TD ≤ 5:1 = ±0.15 ▪ TD > 5:1 = ±0.03 · TD
3 bar (45 psi), 16 bar (240 psi)	▪ TD ≤ 15:1 = ±0.075 ▪ TD > 15:1 = ±[0.0015 · TD + 0.053]	▪ TD ≤ 15:1 = ±0.1 ▪ TD > 15:1 = ±[0.006 · TD + 0.01]
40 bar (600 psi)	-	▪ TD ≤ 15:1 = ±0.1 ▪ TD > 15:1 = ±[0.006 · TD + 0.01]

1) Reference accuracy comprises the non-linearity [DIN EN 61298-2] including the hysteresis [DIN EN 61298-2] and the non-repeatability [DIN EN 61298-2] in accordance with the limit point method as per [DIN EN 60770]. Reference accuracy for standard up to TD 100:1. The specifications refer to the calibrated span / upper range value (URV).
2) FMD77/FMD78: No diaphragm seal errors are taken into account. Diaphragm seal errors can be calculated separately in the Applicator diaphragm seal calculation module. Link to online tool Applicator: www.endress.com/applicator → Sizing Diaphragm Seal

Please refer to the next chapter “Detailed performance explanation and calculation” for further explanations on "Ambient temperature effect" as well as "Static pressure effect" .

Total performance – Specification values

PMD75: total performance as % The specifications refer to the calibrated span/Upper Range Value (URV).										
Measuring cell	**Standard [1]**					**Platinum [1]**				
	TD 1:1	**TD 2:1**	**TD 3:1**	**TD 4:1**	**TD 5:1**	**TD 1:1**	**TD 2:1**	**TD 3:1**	**TD 4:1**	**TD 5:1**
10 mbar (0.15 psi)	±0.30	±0.52	±0.74	±0.96	±1.18	±0.26	±0.44	±0.61	±0.78	±0.96
30 mbar (0.45 psi)	±0.26	±0.41	±0.56	±0.72	±0.88	±0.24	±0.38	±0.52	±0.67	±0.81
100 mbar (1.5 psi)	±0.20	±0.27	±0.34	±0.41	±0.49	±0.20	±0.26	±0.33	±0.40	±0.47
500 mbar (7.5 psi)	±0.11	±0.14	±0.17	±0.20	±0.23	±0.10	±0.13	±0.16	±0.19	±0.22
3 bar (45 psi)	±0.14	±0.18	±0.23	±0.28	±0.33	±0.11	±0.13	±0.16	±0.18	±0.20
16 bar (240 psi)	±0.12	±0.16	±0.20	±0.25	±0.30	±0.10	±0.12	±0.14	±0.16	±0.18
40 bar (600 psi)	±0.12	±0.16	±0.20	±0.25	±0.30	±0.10	±0.12	±0.14	±0.16	±0.18
160 bar (2 400 psi) rel/abs 250 bar (3 750 psi) rel/abs	±0.17	±0.20	±0.24	±0.28	±0.32	-				

1) The specification values apply to the temperature range per ±28 °C (50 °F) (corresponds to the range of −3 to +53 °C (+27 to +127 °F)) for all measuring cells. The specifications apply to a static pressure of 7 bar (105 psi) for measuring cells of 10 mbar (0.15 psi) to 500 mbar (7.5 psi), for larger measuring cells of 70 bar (1 050 psi). The specification values apply to the analog output (i.e. including electronics errors). The specification values apply to membrane material AISI 316L (1.4435), Alloy C .

Long-term stability

PMD75/FMD77/FMD78: long-term stability as % The specifications refer to the upper range limit (URL) [1].			
Measuring cell	**Standard & platinum**		
	1 year	**5 years**	**10 years**
10 mbar (0.15 psi)	± 0.200	± 0.280	± 0.310
30 mbar (0.45 psi)	± 0.200	± 0.280	± 0.310
100 mbar (1.5 psi)	± 0.080	± 0.140	± 0.270
500 mbar (7.5 psi)	± 0.025	± 0.050	± 0.075
3 bar (45 psi)	± 0.038	± 0.075	± 0.150
16 bar (240 psi)	± 0.025	± 0.110	± 0.210
40 bar (600 psi)	± 0.050	± 0.070	± 0.100
160 bar (2 400 psi) rel/abs 250 bar (3 750 psi) rel/abs	± 0.050	± 0.070	± 0.100

1) FMD77FMD78: No diaphragm seal errors are taken into account. Diaphragm seal errors can be calculated separately in the Applicator diaphragm seal calculation module. Link to online tool Applicator: www.endress.com/applicator → Sizing Diaphragm Seal

Detailed Performance Explanation and Calculation

To calculate the total performance outside the temperature range of −3 to +53 °C (+27 to +127 °F) or for a membrane material other than 1.4435/316L or Alloy C 276, please refer to the following sections: "Ambient temperature effect", "Static pressure effect" and "Calculating the total performance" [1].

Ambient temperature effect [E2]

- $E2 = (E2_M \cdot CF_1 \cdot CF_2) + E2_E + E2_{LT}$
- $E2_M$ = Main temperature error
- CF_1 = Temperature range correction factor
- CF_2 = Membrane material correction factor (thermal)
- $E2_E$ = Electronics error for analog output
- $E2_{LT}$ = low temperature error

$E2_M$ - Main temperature error

The output changes due to the effect of ambient temperature [IEC 61298-3] with respect to reference temperature [DIN 16086]. The values specify the maximum error due to min./max. ambient or process temperature conditions.

PMD75/FMD77/FMD78: main temperature error $E2_M$ as % per ±28 °C (50 °F) (corresponds to the range of −3 to +53 °C (+27 to +127 °F)) The specifications refer to the calibrated span/Upper Range Value (URV).		
Measuring cell	**Standard**	**Platinum**
10 mbar (0.15 psi), 30 mbar (0.45 psi)	± (0.14 · TD + 0.04)	± (0.14 · TD + 0.04)
100 mbar (1.5 psi)	± (0.07 · TD + 0.07)	± (0.07 · TD + 0.07)
500 mbar (7.5 psi)	± (0.03 · TD + 0.017)	± (0.03 · TD + 0.017)
3 bar (45 psi), 16 bar (240 psi), 40 bar (600 psi)	± (0.012 · TD + 0.017)	± (0.012 · TD + 0.017)
160 bar (2 400 psi) rel/abs	± (0.042 · TD + 0.04)	-
250 bar (3 750 psi) rel/abs	± (0.022 · TD + 0.04)	-

CF_1 - Temperature range correction factor

PMD75/FMD77/FMD78: correction factor CF_1		
Measuring cell	**Temperature range**	**Factor, CF_1**
For all measuring cells	25 °C ± 28 °C (−3 to +53 °C (+27 to +127 °F))	1
	−32 to −4 °C (−26 to +25 °F) and +54 to +85 °C (+129 to +185 °F)	2
	−50 to −33 °C (−58 to −27 °F)	2.3

CF_2 - Membrane material correction factor (thermal) (only for PMD75)

PMD75: correction factor CF_2					
Measuring cell	**AISI 316L**	**Alloy C**	**Gold-Rhodium**	**Monel**	**Tantalum**
10 mbar (0.15 psi)	1.0	1.0	2.5	2.8	2.3
30 mbar (0.45 psi)	1.0	1.0	2.5	2.8	2.3
100 mbar (1.5 psi)	1.0	1.0	1.1	1.1	1.1
500 mbar (7.5 psi)	1.0	1.0	1.8	1.8	1.8

1) FMD77FMD78: No diaphragm seal errors are taken into account. Diaphragm seal errors can be calculated separately in the Applicator diaphragm seal calculation module. Link to online tool Applicator: www.endress.com/applicator → Sizing Diaphragm Seal

PMD75: correction factor CF_2					
Measuring cell	**AISI 316L**	**Alloy C**	**Gold-Rhodium**	**Monel**	**Tantalum**
3 bar (45 psi)	1.0	1.0	3.1	3.1	3.1
16 bar (240 psi)	1.0	1.0	4.7	4.7	4.7
40 bar (600 psi)	1.0	1.0	3.1	3.1	3.1
160 bar (2 400 psi) rel/abs 250 bar (3 750 psi) rel/abs	1.0	1.0	-	-	-

$E2_E$ - Electronics error

PMD75/FMD77/FMD78: electronics error $E2_E$ as % The specifications refer to the calibrated span/Upper Range Value (URV).			
Measuring cell	**Electronics**	**Temperature range**	**Error** [1]
For all measuring cells	Analog output (4 to 20 mA)	−50 to +85 °C (−58 to +185 °F)	0.05
	Digital output (HART)	−50 to +85 °C (−58 to +185 °F)	0
	Digital output (PA/FF)	−40 to +85 °C (−40 to +185 °F)	0

1) The additional electronics error that occurs in the temperature range −50 to −41 °C (−58 to −42 °F) is covered by $E2_{LT}$.

$E2_{LT}$ - low temperature error

PMD75/FMD77/FMD78: low temperature error $E2_{LT}$ as % The specifications refer to the calibrated span/Upper Range Value (URV).		
Measuring cell	**Temperature range**	**Problem**
For all measuring cells	−40 to +85 °C (−40 to +185 °F)	0
	−50 to −41 °C (−58 to −42 °F)	1.5

Static pressure effect [E3]

- $E3 = E3_M \cdot CF_3$
- $E3_M$ = main static pressure error ($E3_M$ = zero point error + span error)
- CF_3 = Membrane material correction factor (static pressure)

$E3_M$ - Main static pressure error

Static pressure effect refers to the effect on the output due to changes in process static pressure. It is the difference between the output at each static pressure and the output at atmospheric pressure [IEC 61298-3]. It is the combination of influence of the operating pressure on the zero point and span.

PMD75/FMD77/FMD78: main static pressure error $E3_M$ as % The specifications refer to the calibrated span/Upper Range Value (URV).				
Measuring cell	**Standard**		**Platinum**	
	on the zero point [1]	**on the span**	**on the zero point** [1]	**on the span**
10 mbar (0.15 psi)	± 0.15 · TD per 7 bar (105 psi)	± 0.035 per 7 bar (105 psi)	± 0.07 · TD per 7 bar (105 psi)	± 0.035 per 7 bar (105 psi)
30 mbar (0.45 psi)	± 0.70 · TD per 70 bar (1 050 psi)	± 0.14 per 70 bar (1 050 psi)	± 0.25 · TD per 70 bar (1 050 psi)	± 0.14 per 70 bar (1 050 psi)
100 mbar (1.5 psi)	± 0.203 · TD per 70 bar (1 050 psi)	± 0.15 per 70 bar (1 050 psi)	± 0.077 · TD per 70 bar (1 050 psi)	± 0.15 per 70 bar (1 050 psi)
500 mbar (7.5 psi)	± 0.07 · TD per 70 bar (1 050 psi)	± 0.10 per 70 bar (1 050 psi)	± 0.028 · TD per 70 bar (1 050 psi)	± 0.10 per 70 bar (1 050 psi)

PMD75/FMD77/FMD78: main static pressure error $E3_M$ as % The specifications refer to the calibrated span/Upper Range Value (URV).				
Measuring cell	Standard		Platinum	
	on the zero point [1]	on the span	on the zero point [1]	on the span
3 bar (45 psi)	± 0.049 · TD per 70 bar (1 050 psi)	± 0.05 per 70 bar (1 050 psi)	± 0.021 · TD per 70 bar (1 050 psi)	± 0.05 per 70 bar (1 050 psi)
16 bar (240 psi), 40 bar (600 psi)	± 0.049 · TD per 70 bar (1 050 psi)	± 0.02 per 70 bar (1 050 psi)	± 0.021 · TD per 70 bar (1 050 psi)	± 0.02 per 70 bar (1 050 psi)
160 bar (2 400 psi) rel/abs 250 bar (3 750 psi) rel/abs	-	-	-	-

1) The influence of the operating pressure on the zero point can be corrected. Please refer to operating instructions and chapter Commissioning → Position adjustment.

CF_3 – Membrane material correction factor (static pressure) (applicable only to PMD75)

PMD75: membrane material correction factor $CF3_3$					
Measuring cell	AISI 316L	Alloy C	Gold-Rhodium	Monel	Tantalum
10 mbar (0.15 psi)	1.0	1.0	1.0	1.4	2.1
30 mbar (0.45 psi)	1.0	1.0	1.5	2.0	3.1
100 mbar (1.5 psi)	1.0	1.0	2.5	2.5	2.5
500 mbar (7.5 psi)	1.0	1.0	1.2	1.2	1.8
3 bar (45 psi)	1.0	1.0	2.1	2.1	2.8
16 bar (240 psi)	1.0	1.0	3.0	3.0	4.0
40 bar (600 psi)	1.0	1.0	3.0	3.0	4.0
160 bar (2 400 psi) rel/abs 250 bar (3 750 psi) rel/abs	-	-	-	-	-

Total error

Total error = total performance + long-term stability

Total performance as % of the set span with TD 1:1 → 🖹 28

Long-term stability as % of the upper range limit (URL) → 🖹 29

PMD75: total error as % The specifications refer to the upper range limit (URL).						
Measuring cell	Standard [1]			Platinum [1]		
	1 year	5 years	10 years	1 year	5 years	10 years
10 mbar (0.15 psi)	± 0.50	± 0.58	± 0.61	± 0.46	± 0.54	± 0.57
30 mbar (0.45 psi)	± 0.46	± 0.54	± 0.57	± 0.44	± 0.52	± 0,55
100 mbar (1.5 psi)	± 0.28	± 0.34	± 0,47	± 0.28	± 0.34	± 0,47
500 mbar (7.5 psi)	± 0.14	± 0.16	± 0.19	± 0,13	± 0.15	± 0.18
3 bar (45 psi)	± 0.17	± 0.21	± 0.29	± 0.15	± 0.19	± 0.26
16 bar (240 psi)	± 0.14	± 0.23	± 0.33	± 0.12	± 0.21	± 0.31
40 bar (600 psi)	± 0.17	± 0.19	± 0.22	± 0.15	± 0.17	± 0.20
160 bar (2 400 psi) rel/abs 250 bar (3 750 psi) rel/abs	± 0.22	± 0.24	± 0,27	-		

1) The specification values apply to the temperature range per ±28 °C (50 °F) (corresponds to the range of −3 to +53 °C (+27 to +127 °F)) for all measuring cells. The specifications apply to a static pressure of 7 bar (105 psi) for measuring cells of 10 mbar (0.15 psi) to 500 mbar (7.5 psi), for larger measuring cells of 70 bar (1 050 psi). The specification values apply to the analog output (i.e. including electronics errors). The specification values apply to membrane material AISI 316L (1.4435), Alloy C .

Performance characteristics - calculation example and additional information

Calculating the total performance in 5 steps

Data (Example)

Measuring Conditions / Device configuration	
dP range (URV)	8 bar (116 psi)
Min./ Max. temp. differential pressure transmitter (ambient/process)	Ambient temp.:0 to 45 °C (32 to 113 °F) Max. Process temp.:50 °C (122 °F)
Membrane material	AISI 316L
Reference accuracy (± 0.05%)	Standard
PMD75 - suitable measuring cell (upper range limit, URL)	16 bar (240 psi) with TD 2:1
Static pressure	35 bar (508 psi)
Output Signal	4 to 20 mA

Formula

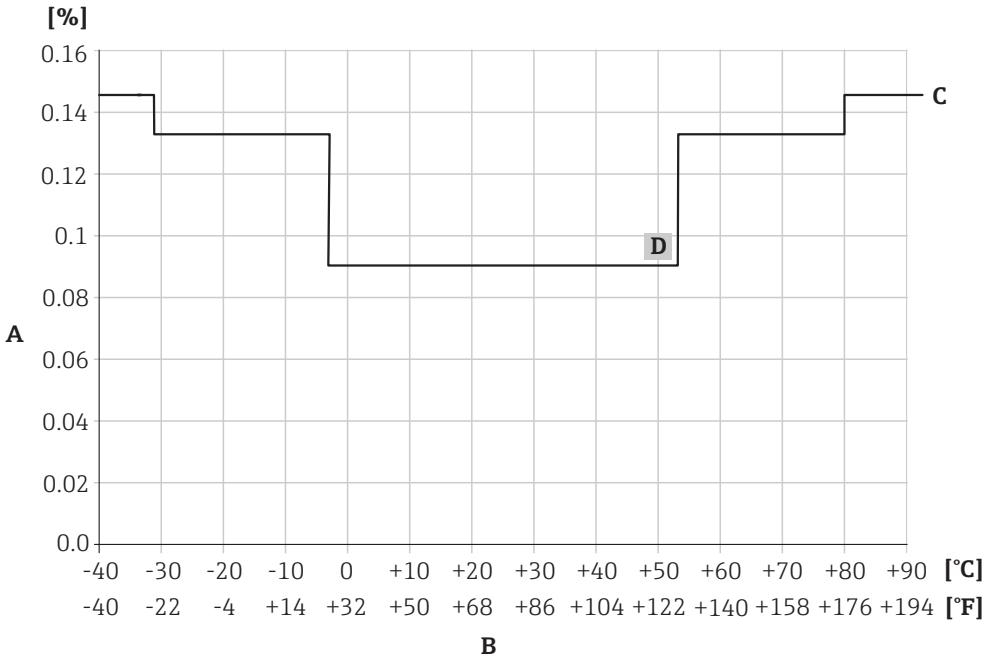
Total performance	=	$\pm \sqrt{ (E1)^2 + (E2)^2 + (E3)^2 }$
E1	=	Reference accuracy → 🖹 27
E2	=	Ambient temperature effect per ±28 °C (50 °F) (corresponds to the range of −3 to +53 °C (+27 to +127 °F)) → 🖹 30
E3	=	Static pressure effect → 🖹 31

Calculation

Step 1: Calculating the turn down → 🖹 7		
Turn down (TD) = URL/ | URV - LRV |	=	16 bar (240 psi)/8 bar (116 psi)
	=	TD = 2:1
Step 2: Calculating the reference accuracy (E1) → 🖹 27		
For the measuring conditions,		
Reference accuracy, E1	=	± 0.05 (% of the set span)
	=	± (0.05/100) · 8 bar (116 psi)
	=	±0.0040 bar (0.0580 psi)
	E1 =	± 0.05 (% of the set span)
	(or)	±0.0040 bar (0.0580 psi)

Step 3: Calculation of the ambient temperature effect [$E2 = (E2_M \cdot CF_1 \cdot CF_2) + E2_E + E2_{LT}$] → 🖹 30

For the measuring conditions, Main temperature error, $E2_M$	=	± (0.012 · TD + 0.017) % of the set span
Temperature correction factor, CF_1	=	1
Membrane material correction factor, CF_2	=	1
Electronics error , $E2_E$	=	0.05 %
Low temperature error $E2_{LT}$	=	0 %
Ambient temperature effect, E2	=	± [(0.012 · TD + 0.017) · 1 · 1] +0.05
	=	± [(0.012 · 2 + 0.017) · 1 · 1] + 0.05
	=	± 0.091 (% of the set span)
	=	± (0.091/100) · 8 bar (116 psi)
	=	±0.0073 bar (0.10585 psi)
E2	=	± 0.091 (% of the set span)
	(or)	±0.0073 bar (0.10585 psi)



A0031069

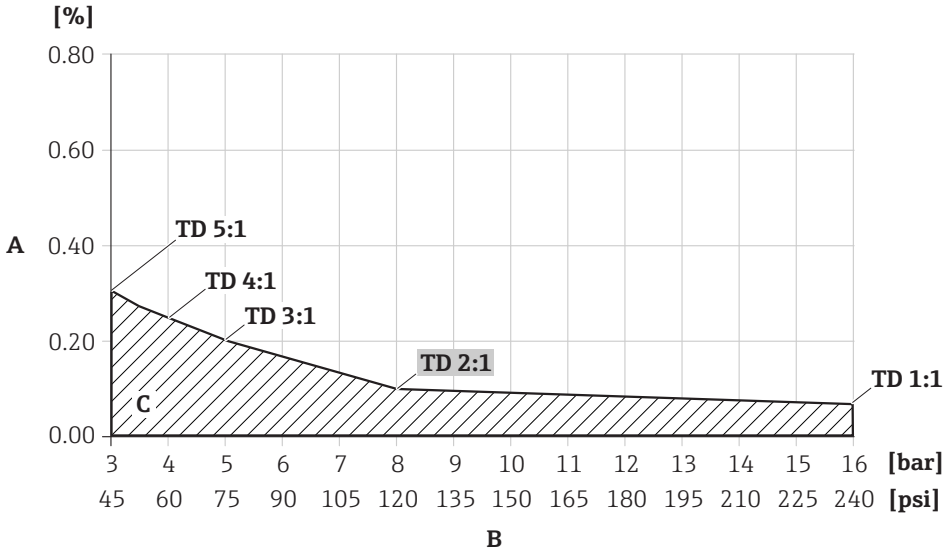
A Error (% of the set span)
B Temperature
C Measuring membrane made from 316L or Alloy C
D Ambient temperature effect: 0.091 (% of the set span) (E_2 at 50 °C (122 °F))

Step 4: Calculating the static pressure effect ($E3 = E3_M \cdot CF_3$) → 🖹 31

For the measuring conditions, Main static pressure error, $E3_M$	=	± (0.049 · TD) on the zero point and ± 0.02 on the span (% of the set span) per 70 bar (1015 psi)
	=	[± (0.049 · TD) on the zero point and ± 0.02 on the span] · (35/70) (% of the set span) per 35 bar (507.50 psi)
Error factor dependent on membrane material, CF_3	=	1
Static pressure effect, E3	=	± (0.049 · TD + 0.02) · (35/70) · CF_3 (% of the set span)
	=	± (0.049 · 2 + 0.02) · (0.5) · 1
	=	± 0.059 (% of the set span)
	=	± (0.059/100) · 8 bar (116 psi)
	=	±0.0047 bar (0.06815 psi)
E3	=	± 0.059 (% of the set span)
	(or)	±0.0047 bar (0.06815 psi)

Step 5: Calculation of total performance

Total performance	=	$\pm \sqrt{((E1)^2 + (E2)^2 + (E3)^2)}$
		E1 = Reference accuracy E2 = Ambient temperature effect per ±28 °C (50 °F) (corresponds to the range of −3 to +53 °C (+27 to +127 °F)) E3 = Static Pressure Effect
Total performance, in mbar	=	$\pm \sqrt{((0.004)^2 + (0.0073)^2 + (0.0047)^2)}$
	=	± 0.0095 bar (0.13775 psi) or 9.5 mbar (0.13775 psi)
	~	0.119 % of 8 bar (116 psi)
	(or)	
Total performance, in % of the set span	=	$\pm \sqrt{((0.05)^2 + (0.091)^2 + (0.059)^2)}$
	=	± 0.119 (% of the set span)
Total performance	=	± 0.119 (% of the set span)
	(or)	±0.0095 bar (0.13775 psi)

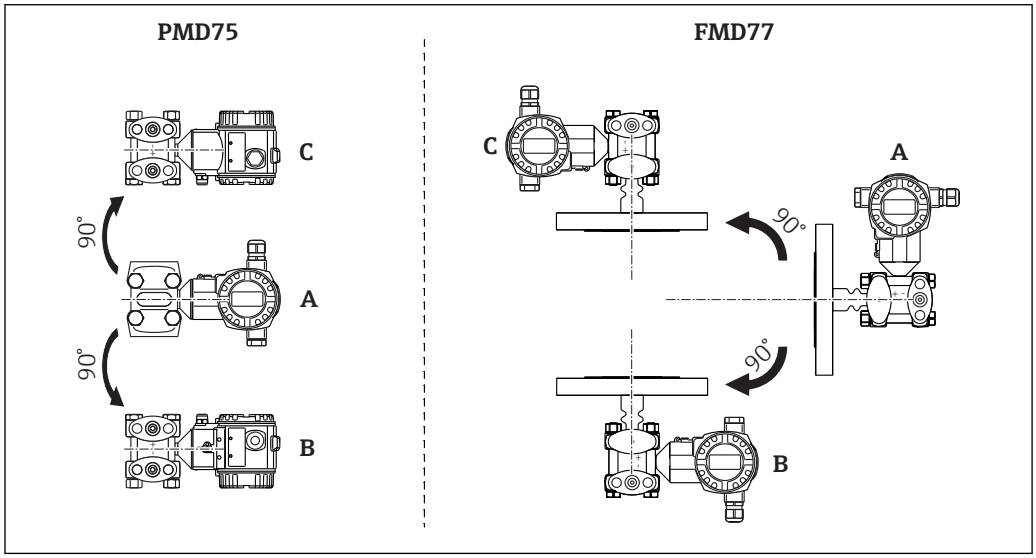


A Error (% of the set span)
B Set span [bar]
C Standard measuring cell

Installation factors

Some of the influencing factors are:
- Influence of installation position → 36
- Vibration effects → 36

Influence of installation position



Device	Calibration position (A)	Device rotated vertically downwards (B)	Device rotated vertically upwards (C)
PMD75 and silicone oil	No additional error	<+4 mbar (+0.06 psi) The value is doubled for inert oil.	<−4 mbar (−0.06 psi) The value is doubled for inert oil.
FMD77 and silicone oil	No additional error	<+32 mbar (+0.46 psi) The value is doubled for inert oil.	<−32 mbar (−0.46 psi) The value is doubled for inert oil.

A position-dependent zero point shift can be corrected. Please refer to operating instructions chapter Commissioning → Position adjustment.

Vibration effects

Device/accessory	Measuring cells	Housing	Test standard	Vibration resistance
PMD75	10 mbar (0.15 psi), 30 mbar (0.45 psi)	T14 stainless steel T15 aluminum T17 aluminum	IEC 61298-3	≤ 0.15% URL to 10 to 38 Hz: ±0.35 mm (0.0138 in); 38 to 2000 Hz: 2 g in all 3 planes
		T14 aluminum	IEC 61298-3	≤ 0.15% URL to 10 to 60 Hz: ±0.21 mm (0.0083 in); 60 to 2000 Hz: 3 g in all 3 planes
	≥100 mbar (1.5 psi)	T14 stainless steel T15 aluminum	IEC 61298-3	≤ 0.075 % URL to 10 to 38 Hz: ±0.35 mm (0.0138 in); 38 to 2000 Hz: 2 g in all 3 planes
		T14 aluminum	IEC 61298-3	≤ 0.075 % URL to 10 to 60 Hz: ±0.35 mm (0.0138 in); 60 to 2000 Hz: 5 g in all 3 planes

Performance Characteristics Conformance

All performance characteristics are in conformance to ≥ ± 3 sigma.

Resolution

Current output: 1 µA

Warm-up period

- 4 to 20 mA HART: < 10 s
- PROFIBUS PA: 6 s
- FOUNDATION Fieldbus: 50 s

Reference operating conditions

- As per IEC 60770
- Ambient temperature T_A = constant, in the range +21 to +33 °C (+70 to +91 °F)
- Humidity φ = constant, in the range: 5 to 80 % RH ± 5 %
- Ambient pressure p_A = constant, in range: 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of measuring cell: horizontal ±1° (see also "Influence of installation position" section→ 36)
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value
- Zero based span
- Membrane material for PMD75: AISI 316L (1.4435), Alloy C276, gold/rhodium-coated, Monel
- Membrane material for FMD77, FMD78: AISI 316L (1.4435)
- Filling oil: silicone oil
- Supply voltage: 24 V DC ±3 V DC
- Load with HART: 250 Ω
- Turn down (TD) = URL/ | URV - LRV |

Installation

General installation instructions

- A position-dependent zero point shift can be corrected directly at the device via operating keys, and also in hazardous areas in the case of devices with external operation.
  Diaphragm seals also shift the zero point, depending on the installation position → 98.
- The device housing can be rotated up to 380° .
- Endress+Hauser offers a mounting bracket for installing the device on pipes or walls → 39.
- Use flushing rings for flange and cell diaphragm seals if buildup or clogging can be expected at the diaphragm seal connection. The flushing ring can be fitted between the process connection and diaphragm seal. Material buildup in front of the process isolating diaphragm can be flushed away, and the pressure chamber vented, via the two lateral flushing holes.
- When measuring in media containing solids, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.
- Using a valve manifold allows for easy commissioning, installation and maintenance without interrupting the process.
- General recommendations for the pressure piping can be found in DIN 19210 "Methods for measurement of fluid flow; differential piping for flow measurement devices" or the corresponding national or international standards.
- Install the pressure piping with a continuous gradient of at least 10%.
- When routing the pressure piping outdoors, ensure sufficient anti-freeze protection, e.g. by using pipe heat tracing.
- Point the cable and connector downwards where possible to prevent moisture from entering (e.g. rain or condensation water).

Measuring arrangement

Flow measurement

- The PMD75 is best suited to flow measurement.
- Measuring arrangement for gases: Mount device above the measuring point.
- Measuring arrangement for liquids and vapors: Mount device below the measuring point.
- For flow measurement in vapors, mount the condensate traps at the same level as the tapping point and at the same distance from the Deltabar S.

Level measurement

The PMD75 and FMD77 are best suited to level measurement in open containers. All Deltabar S devices are suitable for level measurement in closed vessels.

Measuring arrangement for level measurement in open containers
- PMD75: Mount device below the lower measuring connection. The negative side is open to atmospheric pressure.
- FMD77: Mount device directly on the vessel. The negative side is open to atmospheric pressure.

Measuring arrangement for level measurement in closed containers and closed containers with superimposed vapor
- PMD75: Mount device below the lower measuring connection. Always connect the negative side above the maximum level via pressure piping.
- FMD77: Mount device directly on the vessel. Always connect the negative side above the maximum level via pressure piping.
- In the case of level measurement in closed vessels with superimposed vapor, a condensate trap ensures the pressure remains constant on the minus side.

Pressure measurement

- The PMD75 and FMD78 are best suited to differential pressure measurement.
- Measuring arrangement for gases: Mount device above the measuring point.
- Measuring arrangement for liquids and vapors: Mount device below the measuring point.
- For differential pressure measurement in vapors, mount the condensate traps at the same level as the tapping point and at the same distance from the Deltabar S.

Measuring arrangement for devices with diaphragm seals – FMD77 and FMD78

→ 94

Orientation

The orientation may cause a zero point shift, see → 36.

This position-dependent zero point shift can be corrected directly at the device via the operating key, and also in hazardous areas in the case of devices with external operation (position adjustment).

Level | Pressure | Flow | Temperature | Liquid Analysis | Registration | Systems Components | Services | Solutions

Technical Information

Tophit CPS491 and CPS491D

ISFET Sensor for long-term stable pH measurement in media with high dirt loads

Analog or digital sensors with Memosens technology

Application

- Process applications with:
  - Quickly changing pH values
  - Alternating temperatures and pressures
- Water purification and wastewater
- Media with high dirt loads:
  - Solids
  - Emulsions
  - Precipitation processes

With ATEX, FM and CSA approval for application in hazardous areas

Your benefits

- Resistant to breaking
  - Sensor body made completely of PEEK
  - Direct installation into the process, reduces effort and costs for sampling and laboratory analysis
- Double-chamber reference system:
  - poisoning resistant
  - polyacrylamide free gel
- Application possible in heavily soiled media
- Application possible at low temperatures
  - Short response time
  - Constantly high accuracy
- Longer calibration intervals than glass electrodes
  - Lower hysteresis with alternating temperatures
  - Low measuring error after high-temperature loading
  - Almost no acid and alkaline errors
- With built-in temperature sensor for effective temperature compensation

Further benefits offered by Memosens technology

- Maximum process safety through contactless inductive signal transmission
- Data safety through digital data transmission
- Easy handling thanks to storage of sensor-specific data in the sensor
- Predictive maintenance possible thanks to registration of sensor load data in the sensor

TI377C/24/EN/05.10

Endress+Hauser

People for Process Automation

Function and system design

Measuring principle

Ion-**selective**, or more generally ion-**sensitive** field effect transistors (ISFET) were developed in the 1970s as an alternative to the glass electrode for pH measurement.

Basics

Ion-selective field effect transistors use an MOS [1] transistor arrangement (see Fig 1) where the metallic **gate** (pos. 1) is not a control electrode. Instead, the medium (see Fig 2, pos. 3) in the ISFET is in direct contact with the gate isolator layer (pos. 2).Two strongly N-conducting areas are diffused in P-conducting substrate (see Fig 2, pos. 5) of the semiconductor material (Si). These N-conducting areas are current supplying ("**Source**", S) and current accepting ("**Drain**", D) electrodes. The metallic gate electrode (in case of the MOSFET) resp. the medium (in case of the ISFET) forms a capacitor with the substrate below. A potential difference between gate and substrate (U_{GS}) causes a higher electron density between "Source" and "Drain". A N-conducting **channel** (pos. 2) is formed, i.e. a drain current (I_D) is induced.

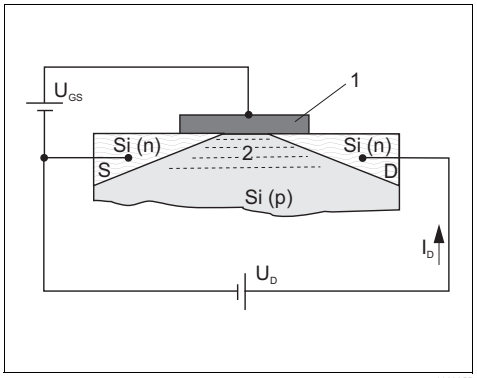


Fig. 1: Principle MOSFET

1 Metallic gate
2 N-conducting channel

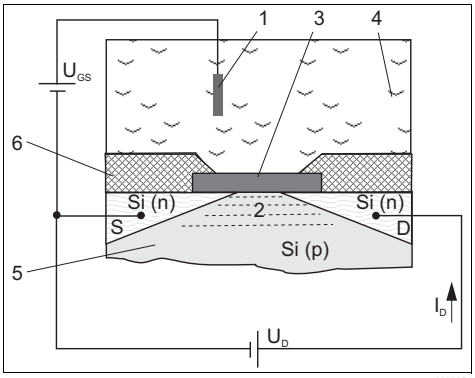


Fig. 2: Principle ISFET

1 Reference electrode
2 N-conducting channel
3 Gate isolator layer
4 Medium
5 P-doped silicon substrate
6 Sensor shaft

With the ISFET, the medium is in direct contact with the gate isolator layer. Therefore, H^+ ions available in the medium, which are located in the medium / gate isolator boundary layer, create the electric field (**gate potential**). Depending on the effect described above, a N-conducting channel is formed and a current between "Source" and "Drain" is induced. Suitable sensor circuits use the dependence on the ion-selective gate potential to create an output signal proportional to the concentration of the ion type.

pH selective IsFET

The gate isolator serves as an ion-selective layer for H^+ ions. The gate isolator is impermeable to the ions as well (isolator effect) but allows reversible surface reactions with the H^+ ions.
Depending on the acidic or alkaline character of the measurement solutions, functional groups in the isolator surface accept or reject H^+ ions (amphoteric character of the functional groups). This leads to a **positive** (H^+ acceptance in the acidic medium) or **negative** (H^+ rejection in the alkaline medium) charging of the isolator surface. Depending on the pH value, a defined surface charge can be used to control the field effect in the channel between "Source" and "Drain".The processes which lead to the creation of a charge potential and therefore to a control voltage U_{GS} between "Gate" and "Source" are described with the Nernst equation:

$$U_{GS} = U_0 + \frac{2.3 \cdot RT}{nF} \cdot \lg a_{ion}$$

U_{GS} ... Potential between gate and source
U_0 ... Offset voltage
R ... Gas constant (8.3143 J/molK)
T ... Temperature [K]
n ... electrochemical valueability (1/mol)
F ... Faraday constant (26.803 Ah)
a_{ion} ... Activity of ion kind (H^+)

$\frac{2.3 \cdot RT}{nF}$ Nernst factor

At 25 °C (77 °F), the Nernst factor is –59.16 mV/pH.

1) Metal Oxide Semiconductor

Important characteristics of Tophit CPS491

- Resistance to breaking
  This is the most obvious feature of the sensor. The complete sensor technology is embedded in a PEEK shaft. Only the highly resistant isolator layer and the reference have direct contact with the medium.
- Acid or alkaline errors
  A further, important benefit compared with the glass electrode is the considerably reduced number of acid or alkaline errors in extreme pH ranges. In contrast to glass electrodes, practically no foreign ions can build up at the ISFET gate. The measuring error of < 0.01 pH (between pH 1 and 13) at 25°C (77 °F) is near by the detection limit.
  The figure below shows the acid or alkaline error of the ISFET between pH 1 and 13 and the comparison to the glass electrode (two different pH glasses) at pH values 0.09 and 13.86.

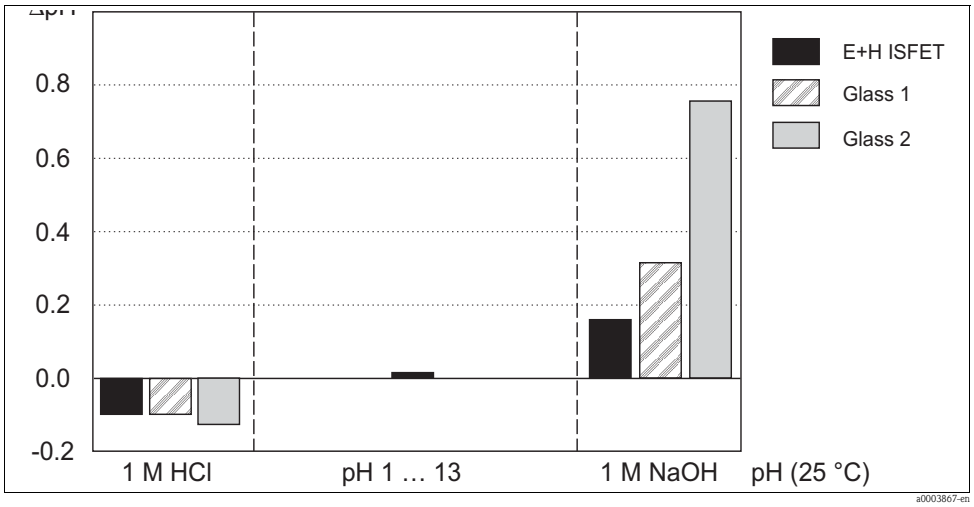


Fig. 3: Comparison of acid and alkaline errors

- Measurement stability and sensor response time
  The ISFET response times are very short over the whole temperature range.
  With the ISFET sensor, there is no (temperature-dependent) equilibrium setting as in the source layer of a pH glass of a glass electrode. They can also be used at low temperatures without a deceleration in response time.Large and fast temperature and pH value fluctuations have a smaller effect on the measuring error (hysteresis) than with a glass electrode, as there is no stress exerted on the pH glass.
- Reference system
  The integrated reference electrode of the sensor is a double-chamber reference system with a bridge electrolyte. The benefits are an efficient and stable contact between the diaphragm and the reference lead, and the extremely long poisoning path. The bridge electrolyte is highly resistant to temperature and pressure changes.

- Isothermic curves
  - The Nernst equation defines the dependence of the measuring voltage on the hydrogen ion content (pH value) and the temperature. It is the basis of pH measuring technology and for ISFET sensors too. A temperature-dependent value for the potential change per pH value can be worked out from this equation (isothermic curve, potential change per pH value at a defined temperature).
  - The isothermic curves of the ISFET sensor are very close to the theoretical values (see Fig 4). This is further proof for the high pH measurement precision of the sensor.

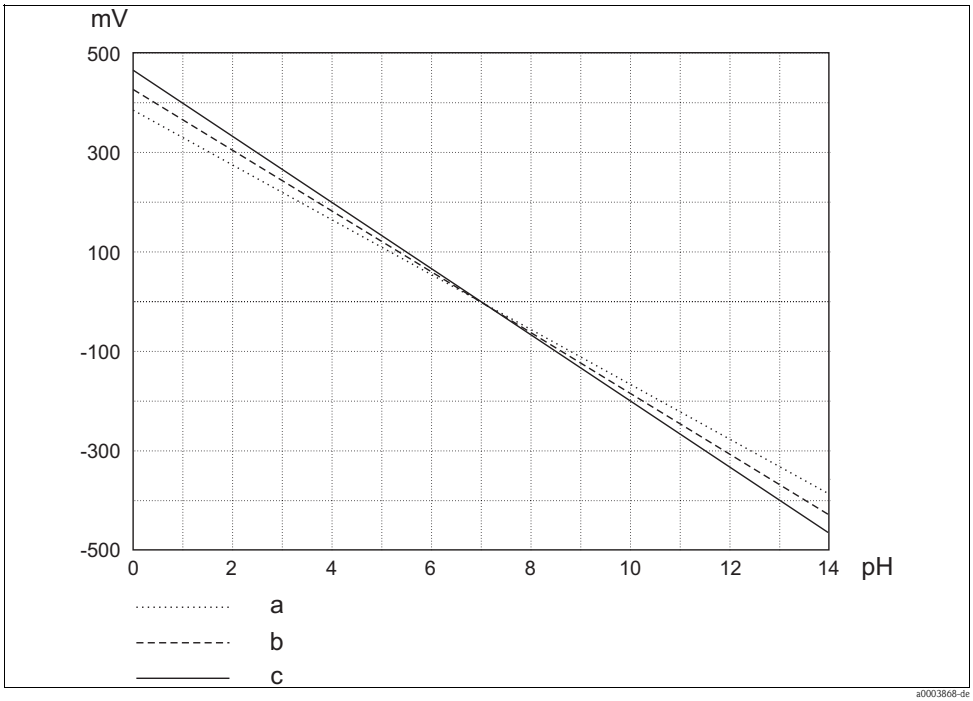


Fig. 4: Isothermic curves

a Isothermic curve at 8 °C (46 °F), slope –55.8 mV/pH
b Isothermic curve at 37 °C (99 °F), slope –61.5 mV/pH
c Isothermic curve at 61 °C (142 °F), slope –66.3 mV/pH

Memosens (CPS491D)

Maximum process safety
The inductive and non-contacting measured value transmission of Memosens guarantees maximum process safety and offers the following benefits:

- All problems caused by moisture are eliminated.
  - The plug-in connection is free from corrosion.
  - Measured value distortion from moisture is not possible.
  - The plug-in system can even be connected under water.
- The transmitter is galvanically decoupled from the medium. The result: No more need to ask about "symmetrically high-impedance" or "unsymmetrical" (for pH/ORP measurement) or an impedance converter.
- EMC safety is guaranteed by screening measures for the digital measured value transmission.
- Application in explosion-hazardous areas is unproblematic; the integrated electronics are intrinsically safe.

Data safety through digital data transfer
The Memosens technology digitalizes the measured values in the sensor and transfers them to the transmitter contactlessly and free from interference potential. The result:

- An automatic error message is generated if the sensor fails or the connection between sensor and transmitter is interrupted.
- The availability of the measuring point is dramatically increased by immediate error detection.

Easy handling
Sensors with Memosens technology have integrated electronics that allow for saving calibration data and further information such as total hours of operation and operating hours under extreme measuring conditions. When the sensor is mounted, the calibration data are automatically transferred to the transmitter and used to calculate the current measured value. Storing the calibration data in the sensor allows for calibration away from the measuring point. The result:

- Sensors can be calibrated under optimum external conditions in the measuring lab. Wind and weather do neither affect the calibration quality nor the operator.
- The measuring point availability is dramatically increased by the quick and easy replacement of precalibrated sensors.
- The transmitter does not need to be installed close to the measuring point but can be placed in the control room.
- Maintenance intervals can be defined based on all stored sensor load and calibration data and predictive maintenance is possible.
- The sensor history can be documented on external data carriers and evaluation programs at any time. Thus, the current application of the sensors can be made to depend on their previous history.

Communication with the transmitter
Always connect digital sensors to a transmitter with Memosens technology. Data transmission to a transmitter for analog sensors is not possible.

The sensor is connected to the cable connection (CYK10) without contact. The power and data are transferred inductively
Once connected to the transmitter, the data saved in the sensor are read digitally. You can call up these data using the corresponding DIAG menu.

Data that digital sensors save include the following:
- Manufacturer data
  - Serial number
  - Order code
  - Date of manufacture
- Calibration data
  - Calibration date
  - Calibration values
  - Number of calibrations
  - Serial number of the transmitter used to perform the last calibration
- Operational data
  - Date of commissioning
  - Hours of operation under extreme conditions
  - Number of sterilizations
  - Data for sensor monitoring.

Measuring system

The complete measuring system comprises at least:
- ISFET sensor Tophit
- Measuring cable CPK12 (analog, with TOP68 connection) or CYK10 (digital, with Memosens)
- Transmitter, e.g. Liquiline CM4x, Liquisys CPM223 (for panel mounting) or Liquisys CPM253 (field instrument) or Mycom CPM153.
- Assembly
  - Immersion assembly, e.g. Dipfit CPA111
  - Flow assembly, e.g. Flowfit CPA250
  - Retractable assembly, e.g. Cleanfit CPA471
    (CPA450 only with CPS471D, CPS491D or special versions CPS471-ESA and CPS491-ESA, —> Ordering information)
  - Fixed installation assembly, e.g. Unifit CPA442

There are additional accessories available depending on the application:
- Topclean CPC30 or Topcal CPC310 automatic cleaning system
- Extension cable, VBA, VBM or RM junction box

Chemicals and process (Ex applications)

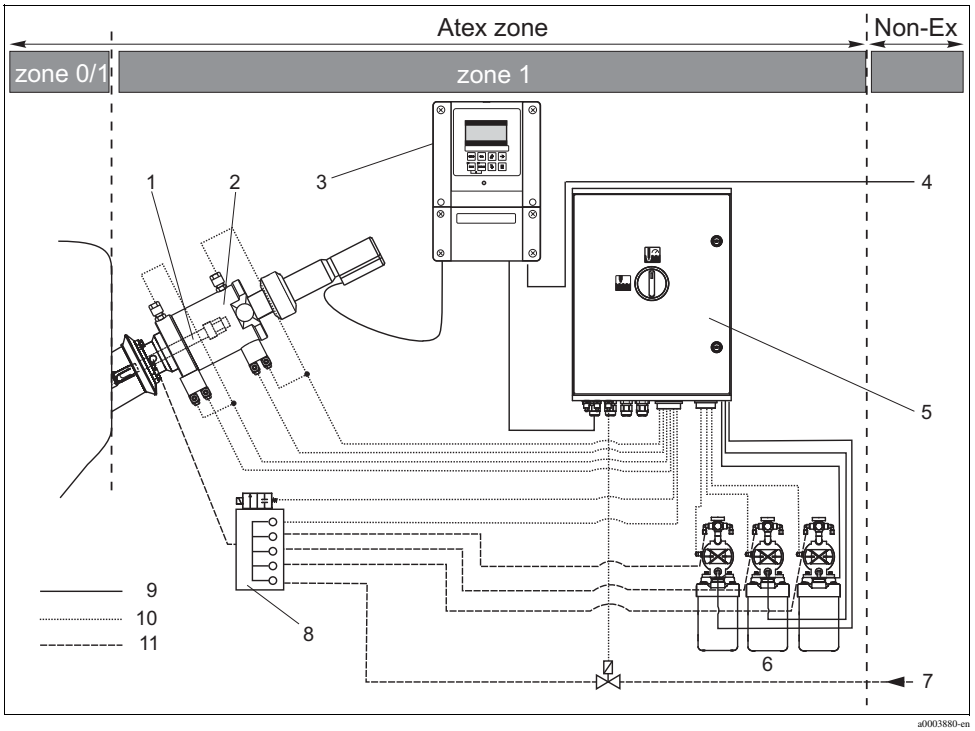


Fig. 5: Measuring system with fully automatic measuring, cleaning and calibration system Topcal

1	Tophit	5	Control unit CPG310	9	Power cable
2	Cleanfit CPA475	6	Cleaner, buffer solutions	10	Compressed air
3	Mycom CPM153	7	Steam, water, cleaner	11	Liquids / cleaner
4	Power supply	8	Rinse block		

Process sterilizibility is no problem due to the wide range of applications for the ISFET pH sensor, not only relating to temperature but also to pH. There is only a small range of high pH values connected with high temperatures where the sensor is not constantly stable (see "Process"). Media with these characteristics remove the isolator oxide from the ISFET chip. As this is the pH and temperature range of CIP cleaning media, the ISFET pH sensor should only be used in combination with an automatic retractable assembly.

Benefits of the Topcal fully automatic measurement, cleaning and calibration system:
- CIP cleaning
  The sensor built into the retractable assembly is automatically "moved" out of the medium before cleaning. In the rinse chamber of the retractable assembly the sensor is cleaned with suitable cleaning solutions.
- Calibration cycles can individually be set.
- Low maintenance costs due to fully automatic cleaning and calibration functions.
- Measuring results are optimally reproducable and the individual value tolerances are very low due to the automatic calibration.

Water and wastewater

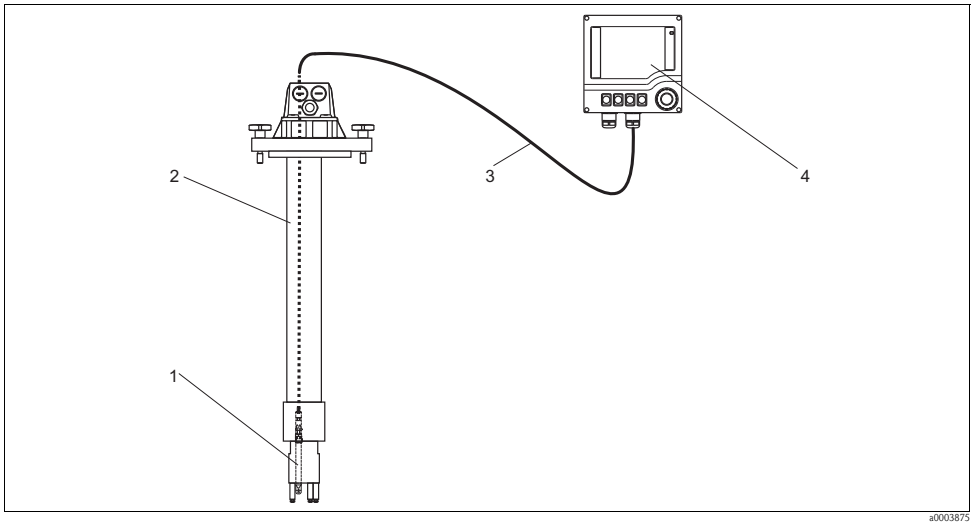


Fig. 6: Measuring system for water and wastewater applications

1 Tophit
2 Immersion assembly Dipfit CPA111
3 Special measuring cable CPK12 or CYK10
4 Transmitter Liquiline

Input

Measured variable

pH value
Temperature

Measuring range

0 to 14 pH
–15 to 110 °C (5 to 230 °F)

Caution!
Note the process operating conditions.

Power supply

Electrical connection CPS491

The sensor is connected to the measuring transmitter using the special measuring cable CPK12.

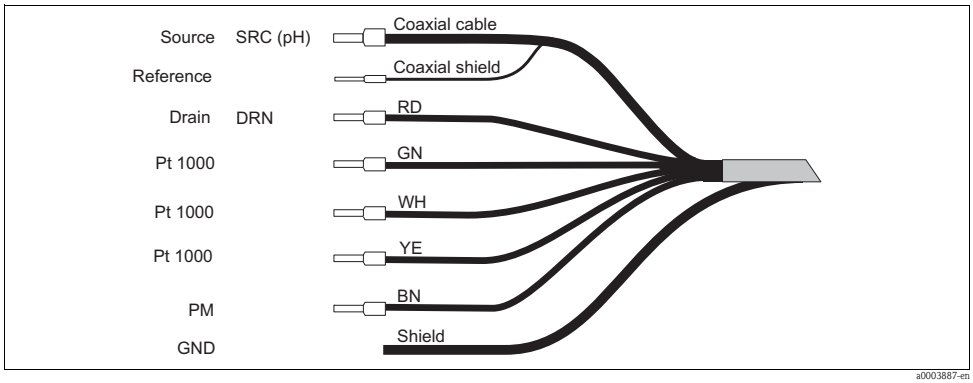


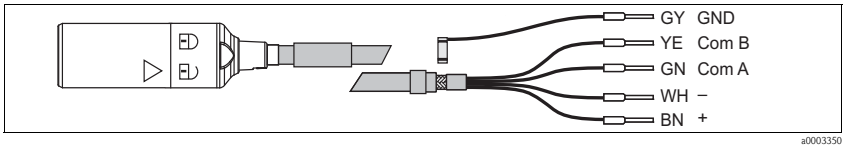
Fig. 7: Special measuring cable CPK12

Note!
- The cable cors Yellow and White are connected on the sensor side.

- Make sure you comply with the instructions for connecting the sensor (wiring diagram) in the Operating Instructions of the transmitter. The transmitter has to be appropriate for the use of ISFET sensors (e.g. Liquiline CM42, Mycom CPM153 or Liquisys CPM223/253-IS).
  A transmitter with only a standard pH input is inappropriate.

Electrical connection CPS491D

The sensor is electrically connected to the transmitter by means of the special measuring cable CYK10.



Special measuring cable CYK10

Performance characteristics

Response time

< 5 s
for buffer change from pH 4 to pH 7 under reference operating conditions

Note!
The response of the integrated temperature sensor can be slower with extreme temperature changes.

Reference operating conditions

Reference temperature:	25 °C (77 °F)
Reference pressure:	1013 mbar (15 psi)

Maximum measured error

pH:	± 0.2 % of measuring range
Temperature:	Class B acc. to DIN IEC 60751

Repeatability

± 0.1 % of measuring range

Start-up drift

Everytime when switching on the measuring device a control loop is set up. During this time the measured value moves to the true value.

The settling time depends on the kind of interruption and the interruption time:
- Supply voltage interruption, sensor left in medium: approx. 3 to 5 minutes
- Interruption of the fluid film between pH sensitive ISFET and reference lead: approx. 5 to 8 minutes
- Longer dry storage of the sensor: up to 30 minutes

Installation

Installation angle

ISFET sensors can be installed in any position, as there is no liquid internal lead. However, in case of an overhead installation, a possible air cushion[2)] in the reference system might interrupt the electrical contact between the medium and the diaphragm.

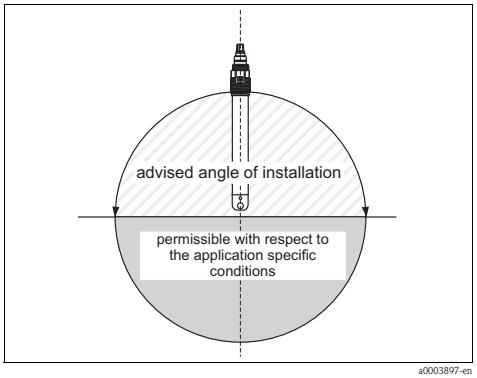


Fig. 8: Angle of installation

2) The sensor is delivered without air cushions. Air cushion formation is possible in case of working with vacuum, e.g. cleaning out of tanks.

Note!
- The installed sensor may be held under dry conditions for maximum 6 hours (also applies to overhead installation).
- Make sure you comply with the instructions in the operating instructions for the assembly used.

Sensor orientation

When installing the sensor, note the flow-past direction of the medium. The ISFET chip should be fixed at an angle of approx 45° to the flow-past direction (see Fig 10). Fixing at the correct angle is very easy because of the rotable plug-in head.

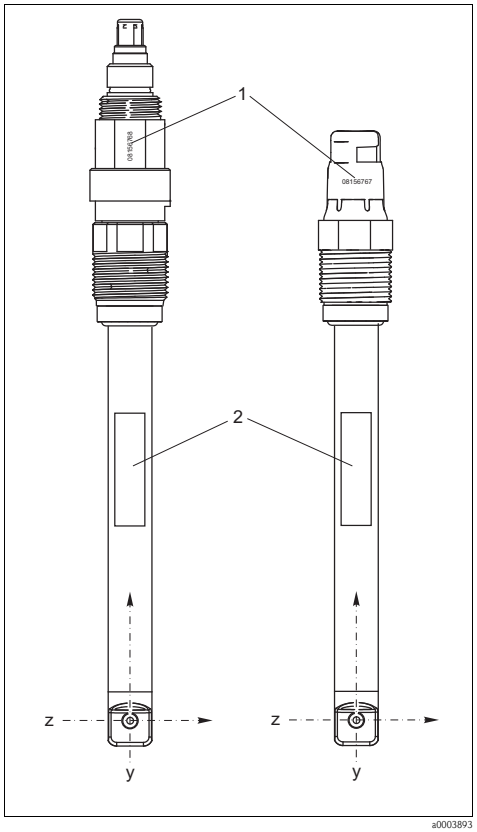


Fig. 9: Sensor orientation, front view

1 Serial number
2 Nameplate

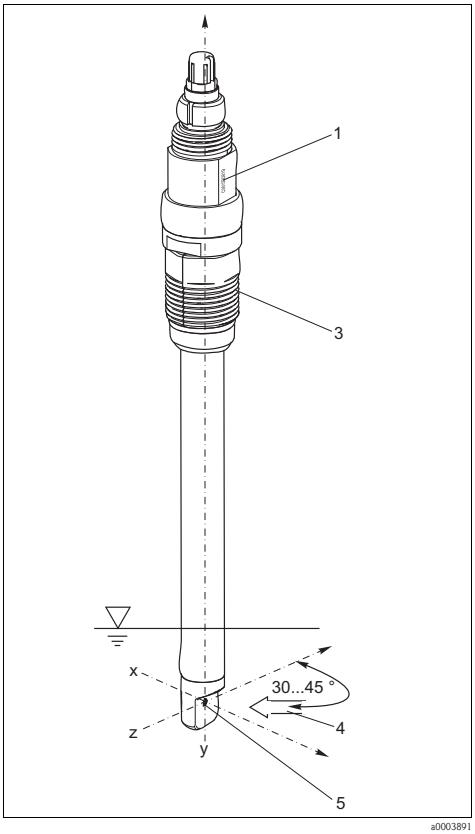


Fig. 10: Sensor orientation, 3d view

1 Serial number
3 rotable part of the connection head
4 Medium flow-past direction
5 ISFET chip

When installing the sensor in an assembly, use the engraved serial number on the connection head for correct sensor orientation. The serial number is always located in the same plane as the ISFET chip and the nameplate (z-y-direction, see Fig 9).

Note!
ISFET sensors are not designed for the use in abrasive media. If you use them in such applications anyhow, you must avoid direct flow against the chip. This considerably lengthens the service life and improves the drift behavior of the sensor. You have however the disadvantage that the display of the pH value is not stable.

Environment

Ambient temperature range

Caution!
Danger of frost damage
Do not operate the sensor at temperatures below –15°C (5 °F).

Storage temperature

0 to 50 °C (32 to 120 °F)

Ingress protection

TOP68:
- IP 68 [1 m (3.3 ft) water column, 50 °C (122 °F), 168 h], autoclavable up to 135 °C (275 °F)

Memosens:
- IP 68 (10 m (32.8) ft water column, 25 °C (77 °F), 45 d, 1M KCl), autoclavable up to 135 °C (275 °F)

Sensitivity to light

As every semiconductor the ISFET is light-sensitive (fluctuations of measured value). Avoid direct sunlight during calibration and operation!
Normal environment light does not influence the measurement.

Process

Medium temperature depending on pH

At high temperatures over a long period of time, alkalis irreversibly destroy the gate isolator oxide.The sensor can only be used in the indicated range (see Fig 11) at a cost to its life span. If it is constantly subjected to the effects of a 2% sodium hydroxide solution at 80°C (176 °F), the sensor life span drops to approx. 10-15 hours.

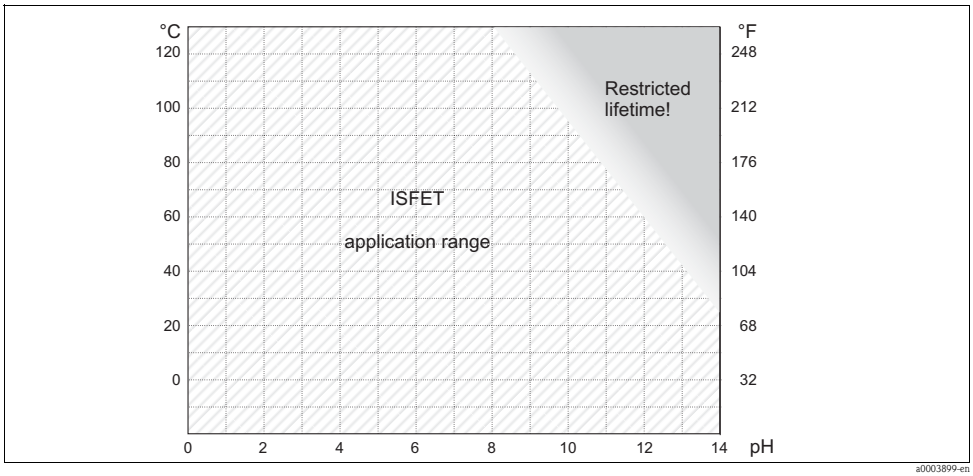


Fig. 11: Temperature and pH

Application at low temperatures

Application range of the sensor according to the order code (see ordering information, product structure)

Pressure-temperature diagram

Max. 10 bar / 100 °C (145 psi / 212 °F), 3 bar / 110 °C (44 psi / 230 °F)

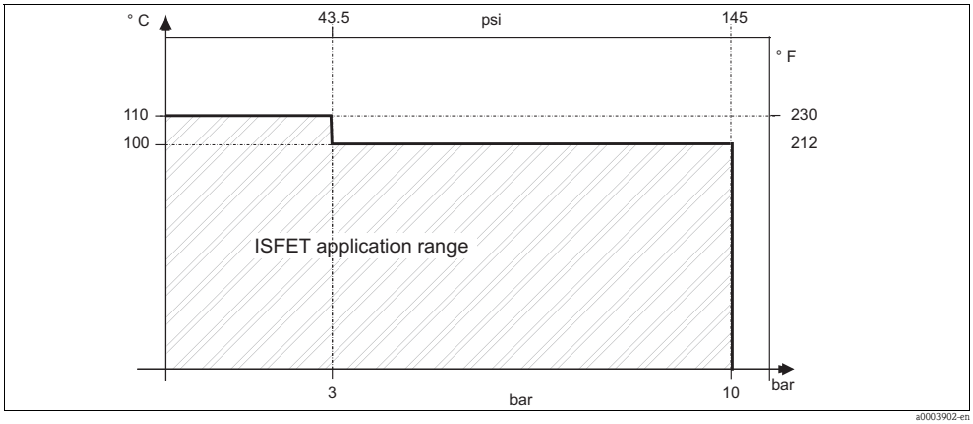


Fig. 12: Pressure-temperature diagram

Caution!
Danger of damage to the sensor
Never use the Tophit for applications outside the given specifications!

Recommended cleaning

Depending on the degree of pollution:
- Hot water / soap (to be preferred)
- Isopropanole
- Chlorine cleaner
- Storing in KCl solution

Mechanical construction

Design, dimensions

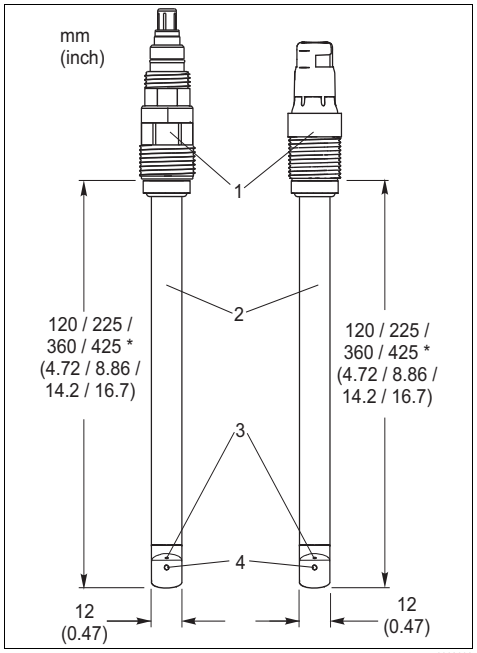


Fig. 13: Tophit CPS491

* depending on the sensor version

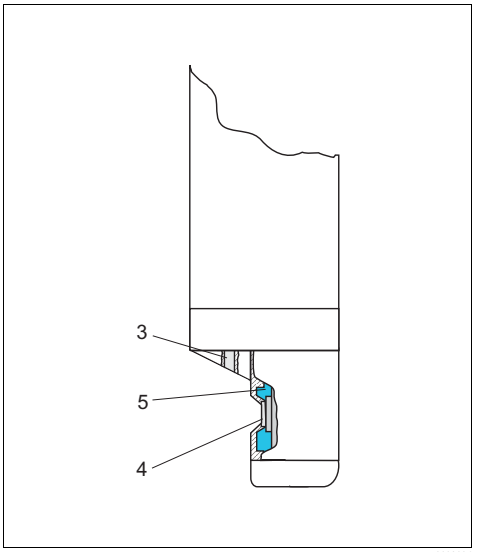


Fig. 14: Sensor head

1 Plug-in head
2 Sensor shaft
3 Reference electrode
4 ISFET chip
5 Seal (perfluoroelastomer)

Weight

0.1 to 0.5 kg (0.2 to 1.1 lbs), depending on the sensor version

Material

Sensor shaft	PEEK, FDA conform
Seals	Perfluoroelastomer

Process connection

Pg 13.5

Surface roughness

R_a < 0.8 µm (31.5 µin)

Temperature sensor

Pt 1000 (class B acc. to DIN IEC 60751)

Plug-in head

CPS491:
- ESB; TOP68, rotatable

CPS491D:
- Memosens, rotatable

Diaphragm

Open aperture

Ordering information

PEEK ISFET sensor for glass free pH measurement
- For media with high dirt loads, also with organic solvents content
- Integrated Pt 1000 temperature sensor
- Double chamber reference system with poisoning resistant gel
- Open aperture
- Sealing material: Perfluoro elastomer
- Application range: pH 0 to 14, –15 to 110 °C (5 to 230 °F)
- For Ex and Non-Ex applications

Product structure CPS491

	Shaft length					
	2	120 mm (4.72 in)				
	4	225 mm (8.86 in)				
	5	360 mm (14.2 in)				
	6	425 mm (16.7 in)				
		Plug-in head				
		ESB	Threaded plug-in head, Pg 13.5, TOP68 rotatable			
			Options			
			2	Chip sealing: Perfluoro elastomer		
CPS491-						**complete order code**

Product structure CPS491D

	Version					
	7	Basic version				
		Shaft length				
		2	120 mm (4.72 in)			
		4	225 mm (8.86 in)			
		5	360 mm (14.2 in)			
		6	425 mm (16.7 in)			
			Additional option			
			2	Perfluoro elastomer		
				Approval		
				G	ATEX II 1G Ex ia IIC T4/T6, FM/CSA IS/NI Cl I DIV 1&2 GP A-D	
				1	Non-hazardous location	
CPS491D-						**complete order code**

Special version

CPS491-ESA
- Open aperture
- Chip sealing: perfluorelastomer
- 120 mm (4.72 inch)
- TOP68 / ESA plug-in head
- Order no.: 51512562

Certificates and approvals

Ex approval FM/CSA

- FM
  IS/NI Cl I DIV 1&2 GP A-D, associated apparatus Mycom 153-O/-P or Liquiline CM42-*P
- CSA
  IS/NI Cl I DIV 1&2 GP A-D, associated apparatus Mycom 153-S or Liquiline CM42-*S

Ex approval ATEX

Device group II, Category 1G
Explosion protection Ex ia IIC T4/T6

Accessories

Note!
In the following sections, you find the accessories available at the time of issue of this documentation.
For information on accessories that are not listed here, please contact your local service or sales representation.

Transmitters

Liquiline CM42
- Modular two-wire transmitter, stainless steel or plastic, field or panel instrument
- Various Ex approvals (ATEX, FM, CSA, Nepsi, TIIS)
- HART, PROFIBUS or FOUNDATION Fieldbus available
- Ordering acc. to product structure, see Technical Information (TI381C/07/en)

Liquisys CPM223/253
- Transmitter for pH and ORP, field or panel-mounted housing
- HART or PROFIBUS available
- Ordering acc. to product structure, see Technical Information (TI194C/07/en)

Mycom CPM153
- Transmitter for pH and ORP, one or two channel version, Ex or non-Ex
- HART or PROFIBUS available
- Ordering acc. to product structure, see Technical Information (TI233C/07/en)

Fully automatic measuring systems

Topcal CPC310
- Fully automatic measuring, cleaning and calibration system; Ex or non-Ex
- In-situ cleaning and calibration, automatic sensor monitoring
- Ordering acc. to product structure, Technical Information TI404C/07/en

Topclean CPC30
- Fully automatic measuring and cleaning system; Ex or non-Ex
- In-situ cleaning, automatic sensor monitoring
- Ordering acc. to product structure, see Technical Information TI235C/07/en

Service tool

Memocheck Plus CYP01D, Memocheck CYP02D
- Tool for the qualification of measuring chains
- Service tool for quick, on-site checks of measuring systems with Memosens technology
- Verification of data transmission
- Ordering acc. to product structure, KA399C/07/a2

Assemblies (selection)

Dipfit CPA111
- Immersion and installation assembly for open and closed tanks
- Technical Information TI112C/07/en

Flowfit CPA250
- Flow assembly for installation in pipework
- Technical Information TI041C/07/en

Cleanfit CPA471
- Retractable assembly for tank and pipe installation
- Technical Information TI217C/07/en

Cleanfit CPA450
- Manual retractable assembly for installing 120 mm sensors in tanks and pipework
- Technical Information TI183C/07/en

Unifit CPA442
- Installation assembly for food, biotechnology and pharmaceuticals, with EHEDG and 3A certificate
- Technical Information TI306C/07/en

Note!
Ordering of assemblies is acc. to product structure. Please refer to the corresponding Technical Information.

Buffer solutions

High-quality buffer solutions of Endress+Hauser - CPY20
The secondary buffer solutions have been referenced to primary reference material of the PTB (German Federal Physico-technical Institute) and to standard reference material of NIST (National Institute of Standards and Technology) according to DIN 19266 by a DKD (German Calibration Service) accredited laboratory.

	pH value
	A pH 2.00 (accuracy ± 0.02 pH)
	C pH 4.00 (accuracy ± 0.02 pH)
	E pH 7.00 (accuracy ± 0.02 pH)
	G pH 9.00 (accuracy ± 0.02 pH)
	I pH 9.20 (accuracy ± 0.02 pH)
	K pH 10.00 (accuracy ± 0.05 pH)
	M pH 12.00 (accuracy ± 0.05 pH)

		Quantity
	01	20 x 18 ml (0.68 fl.oz) only buffer solutions pH 4.00 and 7.00
	02	250 ml (8.45 fl.oz)
	10	1000 ml (0.26 US gal)
	50	5000 ml (1.32 US gal) canister for Topcal S

		Certificates
	A	Buffer analysis certificate

		Version
	1	Standard

CPY20-		complete order code

Cables

CPK12 (TOP68)

	Cable length
	HA Cable length: 5 m (16.41 ft), TPE sheath, max. 130 °C (266 °F)
	HB Cable length: 10 m (32.82 ft), TPE sheath, max. 130 °C (266 °F)
	HC Cable length: 15 m (49.23 ft), TPE sheath, max. 130 °C (266 °F)
	HD Cable length: 20 m (65.64 ft), TPE sheath, max. 130 °C (266 °F)
	HF Cable length: 5 to 20 m (16.41 to 65.64 ft), TPE sheath, max. 130 °C (266 °F)
	HG Cable length: 16 – 160 ft, TPE sheath, max. 130 °C (266 °F)

		Version
	A	Standard version

		Termination
	1	End sleeve on device side, braided cable screening

		Potential matching
	A	External potential matching with flat plug

CPK12-		**complete order code**

CYK10 (Memosens)

CYK10 Memosens data cable
- For digital sensors with Memosens technology
- Ordering according to product structure, see below

	Certificates	
	A	Standard, non-Ex
	G	ATEX II 1G Ex ia IIC T6/T4/T3, FM/CSA IS/NI Cl I DIV 1&2 GP A-D
	L	LABS free, non-Ex
	O	FM IS/NI Cl I DIV 1&2 GP A-D
	S	CSA IS/NI Cl I DIV 1&2 GP A-D
	T	TIIS
	V	ATEX/NEPSI II 3G Ex nL IIC

		Cable length	
		03	Cable length: 3 m (9.8 ft)
		05	Cable length: 5 m (16 ft)
		10	Cable length: 10 m (33 ft)
		15	Cable length: 15 m (49 ft)
		20	Cable length: 20 m (66 ft)
		25	Cable length: 25 m (82 ft)
		88	... m length
		89	... ft length

			Ready-made	
			1	Wire terminals
			2	M12 plug

CYK10-				complete order code

Note!
Ex versions of CYK10 are indicated by an orange-red coupling end.

Cable extension

CYK12

CYK12 measuring cable
- Non-terminated cable for extension of sensor cables, used in combination with CPK1, CPK9 and CPK12
- Coax and 5 pilot wires
- Sold by the meter:
  - Non-Ex version, black: order no. 51506598
  - Ex-version, blue: order no. 51506616

CYK81

CYK81 measuring cable
- Non-terminated measuring cable for extension of sensor cables of e.g. Memosens sensors, CUS31/CUS41
- 2 wires, twisted pair with shield and PVC-sheath (2 x 2 x 0.5 mm^2 + shield)
- Sold by the meter, order no.: 51502543

Junction boxes

Junction box VBA
- For cable extension of pH/ORP sensors
- 10 terminals, protection class: IP 65 (≙ NEMA 4X)
- Cable entries: 2 x Pg 13.5, 2 x Pg 16
- Material: polycarbonate
- Order no.: 50005276

Junction box RM
- For cable extension (e.g. for Memosens sensors or CUS31/CUS41)
- 5 terminals
- Cable entries: 2 x Pg 13.5
- Material: PC
- Ingress protection: IP 65 (≙ NEMA 4X)
- Order no.: 51500832

Junction box VBM
- For cable extension
- 10 terminals
- Cable entries: 2 x Pg 13.5 or 2 x NPT ½"
- Material: aluminum
- Ingress protection: IP 65 (≙ NEMA 4X)
- Order numbers:
  - cable entries Pg 13.5: 50003987
  - cable entries NPT ½": 51500177

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www.mx.endress.com

TI377C/24/en/05.10

TI00183C/07/EN/14.18
71446840
2018-12-31

Technical Information
Cleanfit CPA450

Retractable assembly for fitting and removing 12 mm sensors for pH, redox and oxygen measurement under process conditions

Application

- Universal flow assembly for pH/ORP, oxygen and conductivity sensors
- Power stations
- Chemical industry
- Industrial water treatment
- Supply technology

Your benefits

- Simple fitting and removal of the pH/redox or oxygen sensor for easy maintenance
- Sensor cleaned and calibrated without interrupting the process
- Process is reliably screened off by stainless steel ball valve, ensuring safety during maintenance work
- Use of ISFET sensors and standard gel electrodes 120 mm long
- Three immersion depths up to 700 mm (27.5")
- Safety equipment can be used up to 12 bar (175 psi)
- Integrated rinse connections
- Assembly available in stainless steel, ultra corrosion-resistant C22 nickel alloy and titanium

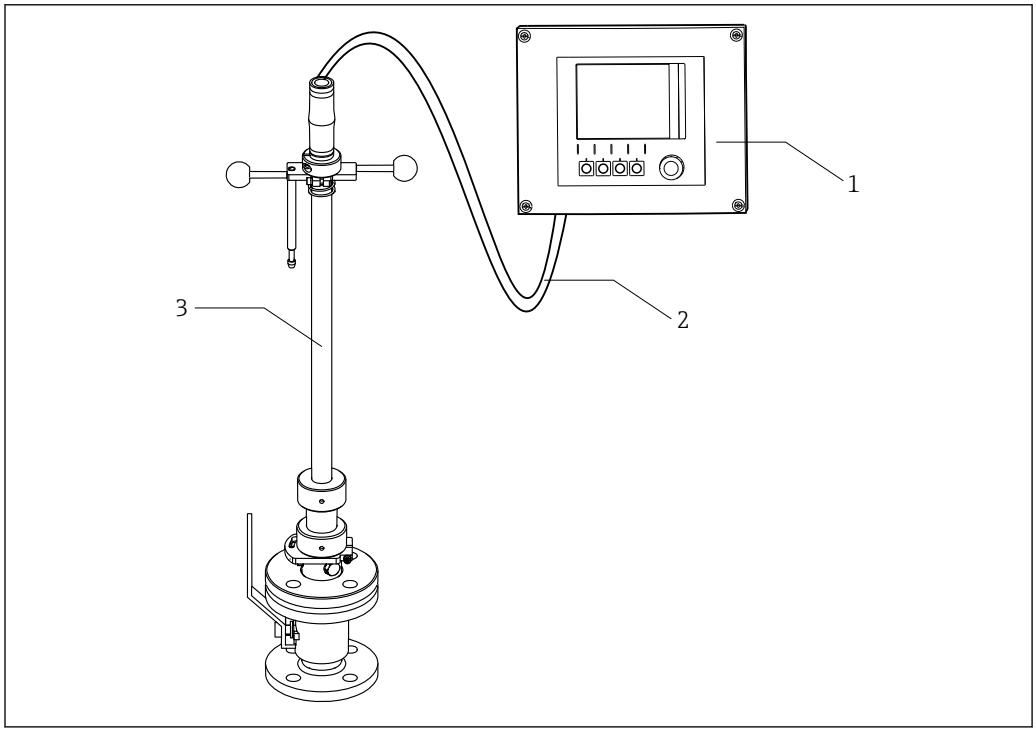
Endress+Hauser
People for Process Automation

Function and system design

Measuring system

A complete measuring system comprises:
- Assembly Cleanfit CPA450
- Oxygen/pH/ORP electrode, length 120 mm (4.72"), e.g. Orbisint CPS11D
- Transmitter, e.g. Liquiline CM44x or Liquiline CM42
- measuring cable, e.g. CYK10

Optional:
- Junction box M12 socket/cable or cable/cable
- Extension cable CYK11



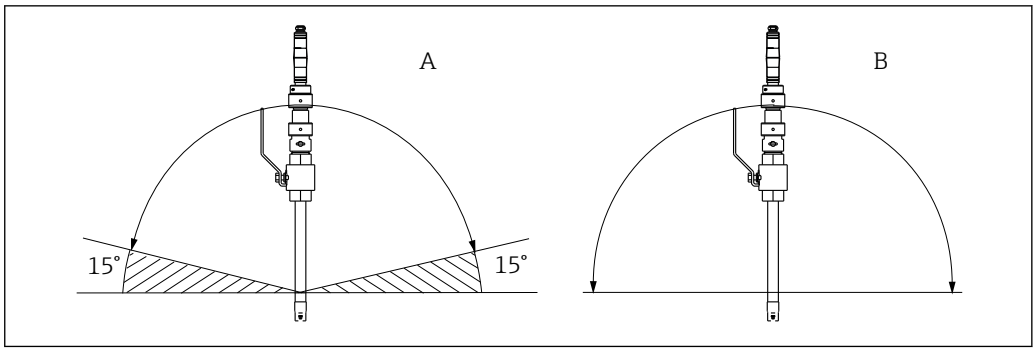
1 Measuring system with CPA450

1 Transmitter Liquiline CM44x
2 Measuring cable CYK10
3 Assembly Cleanfit CPA450

Mounting

Installation instructions

The permitted orientation of the assembly depends on the sensor used:
- Digital sensors with Memosens technology, pH/ORP glass electrodes:
  Install the assembly at an angle of at least 15° to the horizontal → 2, 3.
- ISFET sensors:
  For ISFET sensors, there are basically no restrictions regarding orientation. The installation angle should be from 0 to 180°.
- All other sensors:
  Pay attention to the information in the relevant TI.



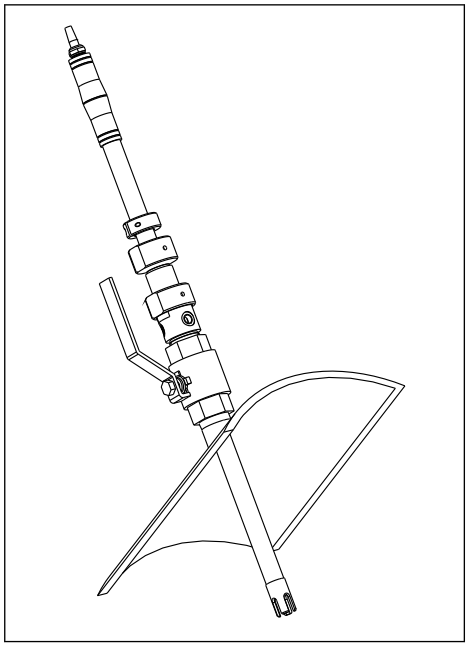
2 *Orientations*

A Glass sensors: 15 ° to the horizontal
B ISFET sensors: 0 to 180° recommended

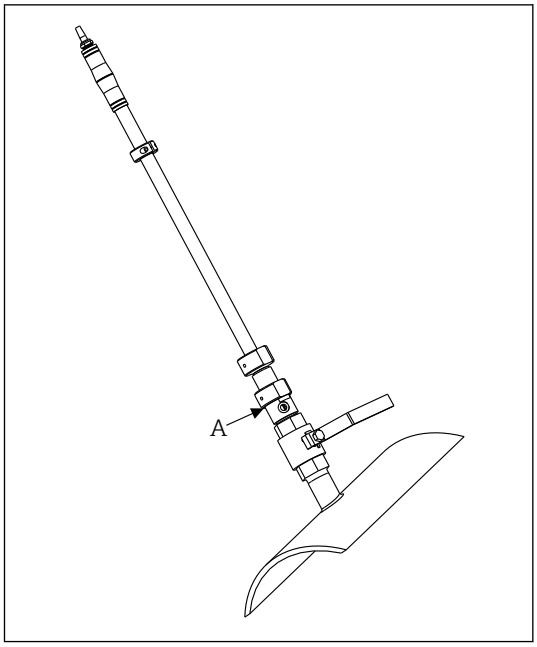
Insert the immersion assembly into the vessel or pipe to a depth that will ensure that medium continuously washes around the electrode, even at the minimum level.

Installation with ball valve

To replace the sensor without interrupting the process, a ball valve is required. Depending on the version, the ball valve forms part of the assembly or must be installed by the customer.



3 *Measuring mode (ball valve is open): assembly is retracted*



4 *Service position (ball valve is closed): assembly is extended for electrode replacement, calibration, rinsing*

A Top edge of adapter

Depending on the assembly version, a mounting clearance of at least 700 or 1150 mm (27.6" or 45.3") is required from the top edge of the adapter.

Environment

Ambient temperature range

0 to 80 °C (32 to 176 °F)

Storage temperature

0 to 80 °C (32 to 176 °F)

Process

Process temperature

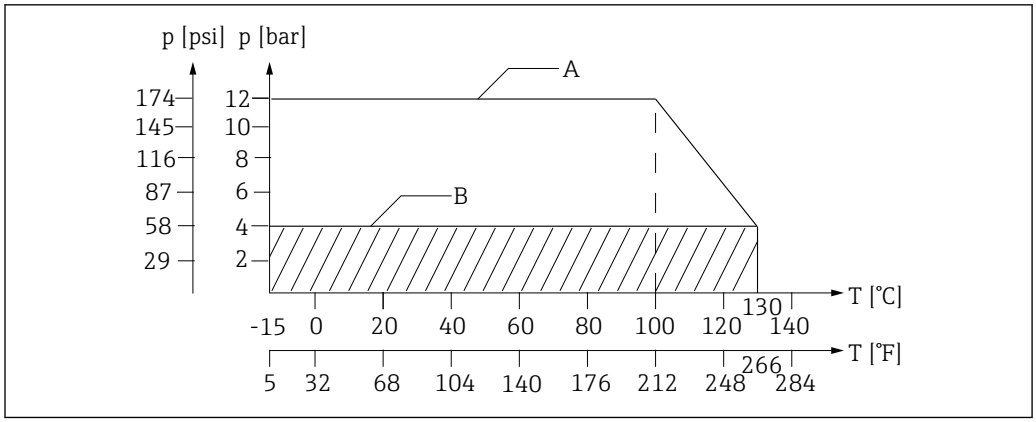
-15 to 130 °C (5 to 266 °F)

Process pressure

max. 12 bar at 100 °C (175 psi at 212 °F)

At pressures above 4 bar (58 psi) the use of a safety kit is strongly recommended.

Pressure-temperature chart



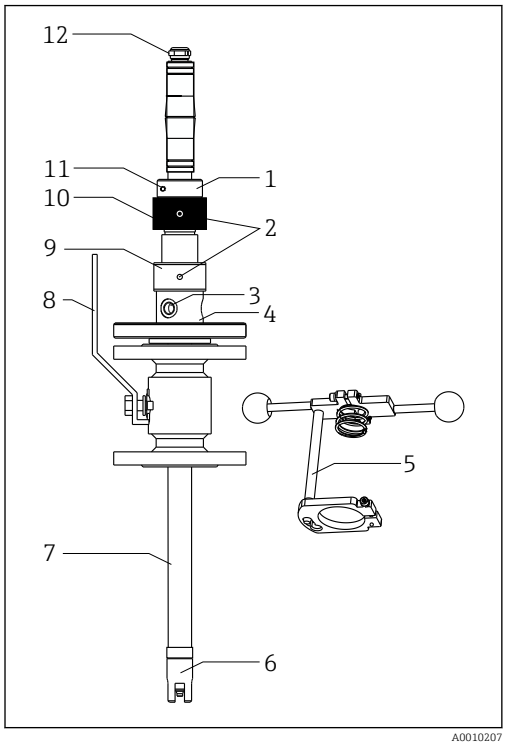
5 Pressure/temperature ratings

A Maximum process pressure (static), only for fully installed assembly
B Maximum pressure for moving the assembly (functional)

Observe the maximum permitted process temperature and process pressure of the sensor.

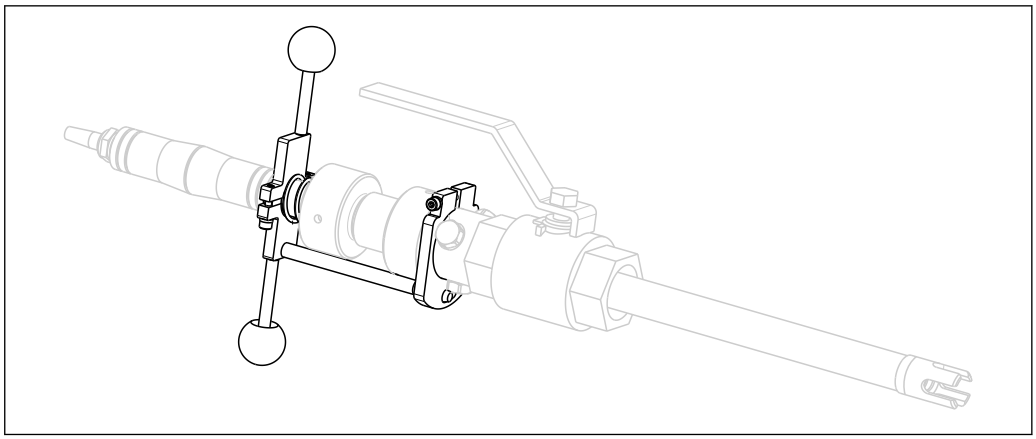
Mechanical construction

Design



6 Assembly in operational state (ball valve open)

1 *Setting collar for fixing the immersion depth*
2 *Bore for hook wrench*
3 *Rinse connection thread ¼ (316L) NPT ¼" (alloy C22 or titanium)*
4 *Service chamber*
5 *Safety kit*
6 *Sensor holder with basket protector*
7 *Immersion tube*
8 *Lever for opening/closing the ball valve*
9 *Lock ring (metal)*
10 *Thread adapter nut (black)*
11 *M5/SW4 hexagon socket*
12 *Cable protector/cable gland*



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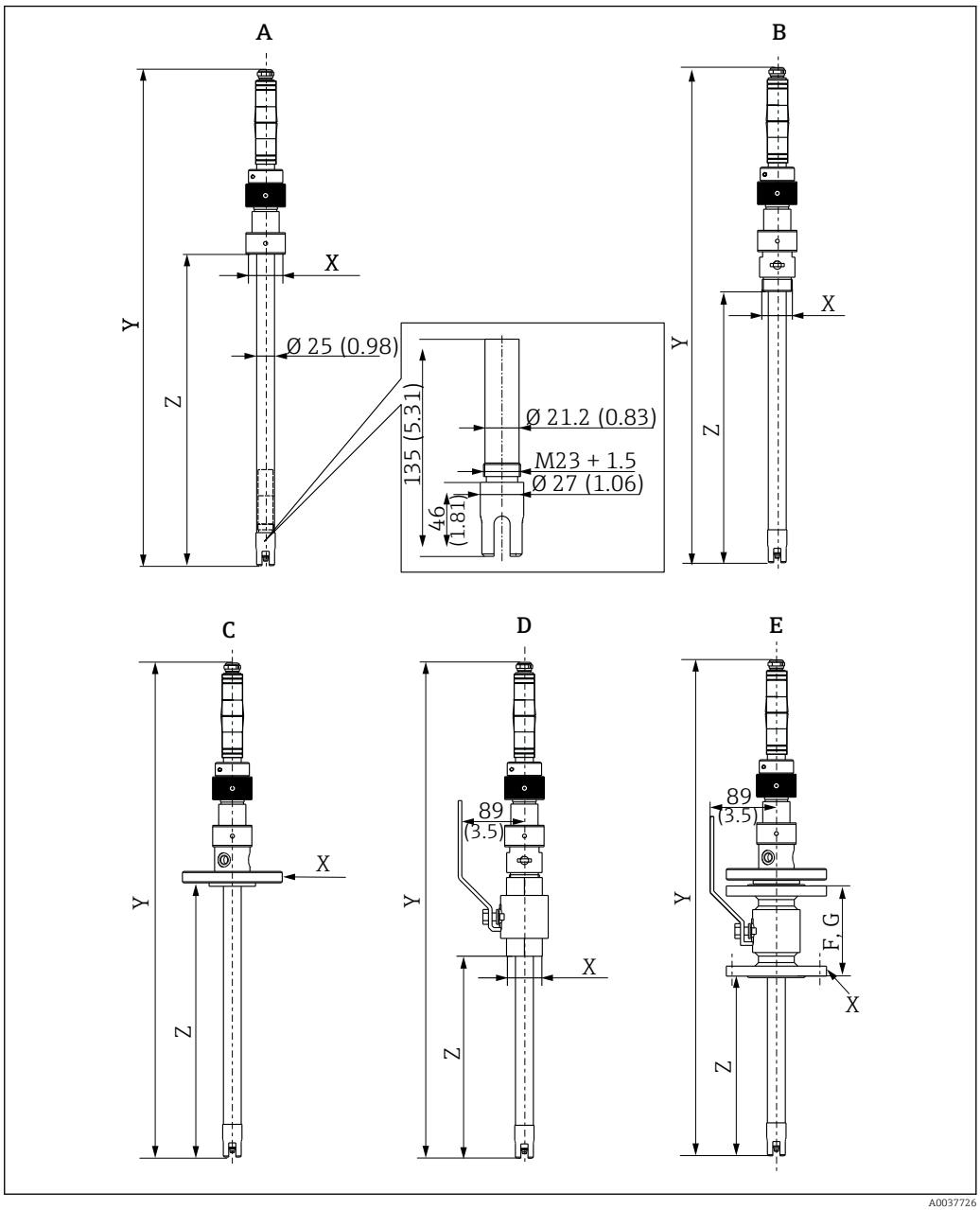
7 *Assembly with safety kit*

Dimensions



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8 *Dimensions (see the following table). Engineering unit in mm (inch)*

F 130 mm (5.12 in) (flange DN32)
G 140 mm (5.51 in) (flange ANSI 1¼")

Type	Assembly	Immersion depth mm (inch)	X Adapter	Y mm (inch)	Z mm (inch)
A	CPA450-*A***	100 (3.94) 250 (9.84) 700 (27.5)	G1½ internal	558 (21.97) 708 (27.87) 1158 (45.59)	275 (10.83) 425 (16.7) 875 (34.5)
B	CPA450-*B***	100 (3.94) 250 (9.84) 700 (27.5)	G1¼ external	558 (21.97) 708 (27.87) 1158 (45.59)	220 (9.06) 370 (14.9) 820 (32.6)
B	CPA450-*C***	100 (3.94) 250 (9.84) 700 (27.5)	NPT 1¼" external	558 (21.97) 708 (27.87) 1158 (45.59)	220 (9.06) 370 (14.9) 820 (32.6)
C	CPA450-*D***	100 (3.94) 250 (9.84) 700 (27.5)	Flange DN32 (as per DIN EN 1092-1)	558 (21.97) 708 (27.87) 1158 (45.59)	225 (8.86) 375 (14.76) 825 (32.48)
C	CPA450-*E***	100 (3.94) 250 (9.84) 700 (27.5)	Flange ANSI 1¼" (as per ASME B16.5)	558 (21.97) 708 (27.87) 1158 (45.59)	225 (8.86) 375 (14.76) 825 (32.48)
D	CPA450-*F***	100 (3.94) 250 (9.84) 700 (27.5)	G1¼ internal	558 (21.97) 708 (27.87) 1158 (45.59)	130 (5.12) 280 (11.2) 730 (28.7)
D	CPA450-*H***	100 (3.94) 250 (9.84) 700 (27.5)	NPT 1¼" external	558 (21.97) 708 (27.87) 1158 (45.59)	130 (5.12) 280 (11.2) 730 (28.7)
E	CPA450-*I***	100 (3.94) 250 (9.84) 700 (27.5)	Flange DN32 (as per DIN EN 1092-1)	558 (21.97) 708 (27.87) 1158 (45.59)	92 (3.62) 242 (9.53) 792 (31.18)
E	CPA450-*K***	100 (3.94) 250 (9.84) 700 (27.5)	Flange ANSI 1¼" (as per ASME B16.5)	558 (21.97) 708 (27.87) 1158 (45.59)	82 (3.23) 232 (9.13) 782 (30.79)
B	CPA450-*M*** and CPA450-*Q***	100 (3.94) 250 (9.84) 700 (27.5)	M-NPT 1½ external	558 (21.97) 708 (27.87) 1158 (45.59)	220 (8.66) 370 (14.57) 820 (32.28)
C	CPA450-*N*** and CPA450-*R***	100 (3.94) 250 (9.84) 700 (27.5)	Flange ANSI 2" (as per ASME B16.5)	558 (21.97) 708 (27.87) 1158 (45.59)	225 (8.86) 375 (14.76) 825 (32.48)

Weight

Depends on version:

Without ball valve: 2 kg (4.41 lbs)

With threaded ball valve: 5 kg (11 lbs)

With flanged ball valve: 10 kg (22.1 lbs)

Materials

In contact with medium	
Immersion tube:	stainless steel 1.4404 (AISI 316 L), Alloy C22, titanium 3.7035
O-rings:	EPDM / Viton / Kalrez
Ball valve:	stainless steel 1.4404 or 1.4408 (AISI 316 L or CF-8M)
Ball valve seals:	PTFE

Not in contact with medium	
Screws:	stainless steel 1.4401 (AISI 316)
Coupling nut (black):	PA66GF
Clamping ring:	PEEK
Handle:	PVC
Cable protector:	thermoplastic elastomer (TPE)

Rinse connection nozzles	For material 316L:	3 x G ¼
	For titanium or Alloy C22:	3 x NPT ¼"

Ordering information

Product page

www.endress.com/cpa450

Product configurator

On the product page there is a **Configure** button to the right of the product image.

1. Click this button.
   ↳ The Configurator opens in a separate window.
2. Select all the options to configure the device in line with your requirements.
   ↳ In this way, you receive a valid and complete order code for the device.
3. Export the order code as a PDF or Excel file. To do so, click the appropriate button on the right above the selection window.

For many products you also have the option of downloading CAD or 2D drawings of the selected product version. Click the **CAD** tab for this and select the desired file type using picklists.

Scope of delivery

The scope of delivery comprises:
- Assembly in the version ordered
- PAL mounting kit
- Hook wrench
- Operating Instructions

▶ If you have any queries:
Please contact your supplier or local sales center.

Accessories

The following are the most important accessories available at the time this documentation was issued.

► For accessories not listed here, please contact your Service or Sales Center.

Accessory kit

Hose nozzles for rinse connections G ¼, DN 12
- Stainless steel 1.4404 (AISI 316 L) x 2
- Order number: 51502808

Hose nozzles for rinse connections G ¼, DN 12
- PVDF (2 x)
- Order number: 50090491

Manometer
- Mount in rinse connection to monitor process pressure
- 0 - 16 bar (0 to 232 psi); G¼
- Order number: 71082362

Drain ball valve
- for draining residual medium; G¼; stainless steel 1.4408 (AISI CF-8M)
- Order number: 71083041

Hook wrench DIN 1810 flat face
- D 58 - 68 mm
- Order number: 50090687

Welding socket

Welding socket G 1¼ straight
- for process connection F
- Dimensions: length 50 mm (1.97 in), Ø 42.6 mm (1.68 in)
- Material: stainless steel 1.4571 (AISI 316 Ti)
- Order number: 51502284

Safety kit
- Mechanical device for securing the measuring position
- For applications in dusty or sooty environments
- For applications involving vibrations or pressure surges
- Order number: 71098681

Sensors

Glass electrodes, analog and digital with Memosens technology

When ordering sensors, please note that only electrode versions with a shaft length of 120 mm (4.72") and a diameter of 12 mm (0.47") are suitable for assembly CPA450. The most commonly used sensors are listed as follows.

Orbisint CPS11D / CPS11
- pH sensor for process technology
- Optional SIL version for connecting to SIL transmitter
- With dirt-repellent PTFE diaphragm
- Product Configurator on the product page: www.endress.com/cps11d or www.endress.com/cps11

Technical Information TI00028C

Orbisint CPS12D / CPS12
- ORP sensor for process technology
- Product Configurator on the product page: www.endress.com/cps12d or www.endress.com/cps12

Technical Information TI00367C

Ceragel CPS71D / CPS71
- pH electrode with reference system including ion trap
- Product Configurator on the product page: www.endress.com/cps71d or www.endress.com/cps71

Technical Information TI00245C

Ceragel CPS72D / CPS72
- ORP electrode with reference system including ion trap
- Product Configurator on the product page: www.endress.com/cps72d or www.endress.com/cps72

Technical Information TI00374C

Orbipore CPS91D / CPS91
- pH electrode with open aperture for media with high dirt load
- Product Configurator on the product page: www.endress.com/cps91d or www.endress.com/cps91

Technical Information TI00375C

ISFET sensors for CPA450

Memosens CPS47D
- Sterilizable and autoclavable ISFET sensor for pH measurement
- Refillable KCl liquid electrolyte
- Product Configurator on the product page: www.endress.com/cps47d

Technical Information TI01412C

Memosens CPS77D
- Sterilizable and autoclavable ISFET sensor for pH measurement
- Product Configurator on the product page: www.endress.com/cps77d

Technical Information TI01396

Memosens CPS97D
- ISFET sensor for pH measurement with long-term stability in media with high dirt loads
- Product Configurator on the product page: www.endress.com/cps97d

Technical Information TI01405C

Oxygen sensors

Oxymax COS22D
- Sterilizable sensor for dissolved oxygen
- With Memosens technology or as an analog sensor
- Product Configurator on the product page: www.endress.com/cos22d

Technical Information TI00446C

Memosens COS81D
- Sterilizable, optical sensor for dissolved oxygen
- With Memosens technology
- Product Configurator on the product page: www.endress.com/cos81d

Technical Information TI01201C

Connection accessories

CPK1
For pH/ORP electrodes with GSA plug-in head

Ordering information is available from your sales office or at www.endress.com.

Measuring cable CPK9
- Terminated measuring cable for connecting analog sensors with TOP68 plug-in head
- Selection in accordance with product structure
- Ordering information: Endress+Hauser sales office or www.endress.com.

Measuring cable CPK12
- Terminated measuring cable for connecting analog ISFET sensors with TOP68 plug-in head
- Selection in accordance with product structure
- Ordering information: Endress+Hauser sales office or www.endress.com

Memosens data cable CYK10
- For digital sensors with Memosens technology
- Product Configurator on the product page: www.endress.com/cyk10

Technical Information TI00118C

Measuring cable CYK71
- Unterminated cable for connecting analog sensors and for extending sensor cables
- Sold by the meter, order numbers:
  - Non-Ex version, black: 50085333
  - Ex-version, blue: 50085673

Measuring cable CYK81
- Unterminated cable for extending sensor cables (e.g. Memosens, CUS31/CUS41)
- 2 x 2 cores, twisted with shielding and PVC sheath (2 x 2 x 0.5 mm^2 + shielding)
- Sold by meter, Order No.: 51502543

VBA
- Junction box for cable extension
- 10 terminal strips
- Cable entries: 2 x Pg 13.5, 2 x Pg 16
- Material: polycarbonate
- Degree of protection: IP 65
- Order number: 50005276

www.addresses.endress.com

Endress+Hauser

People for Process Automation

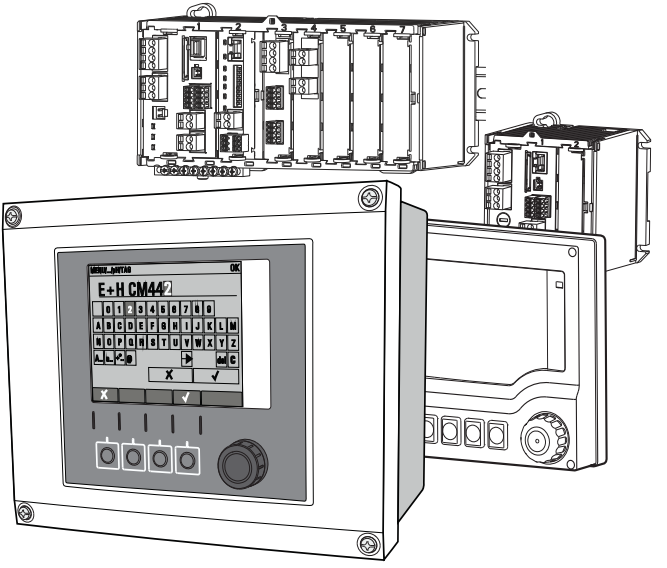
BA00450C/07/EN/17.13
71222845

Valid as of:
Softwareversion 01.04.00

Valid for:
CM442, CM444, CM448,
CM442R, CM444R, CM448R

Operating Instructions
Liquiline CM44x/CM44xR

Universal four-wire multichannel controller
Operation & settings



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Operation concept

This operation concept is valid for CM44x (field device) and CM44xR (DIN rail device) alike. The figures below show the field device.

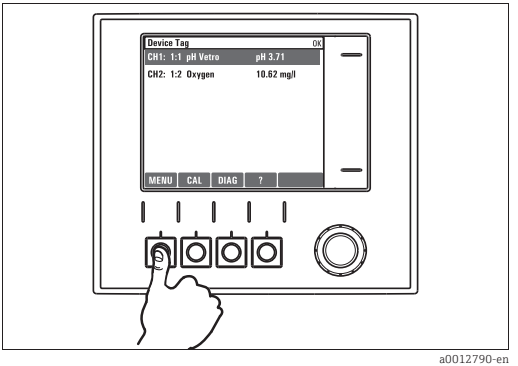

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Fig. 1: Pressing the soft key: selecting the menu directly

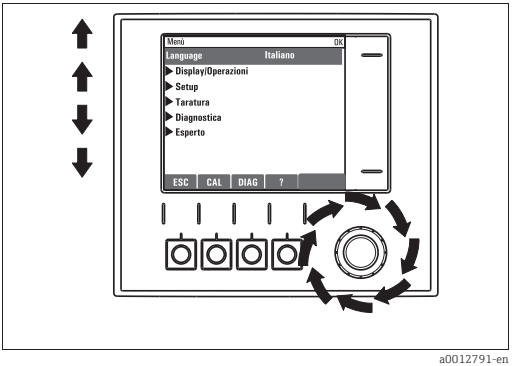

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Fig. 2: Turning the navigator: moving the cursor in the menu

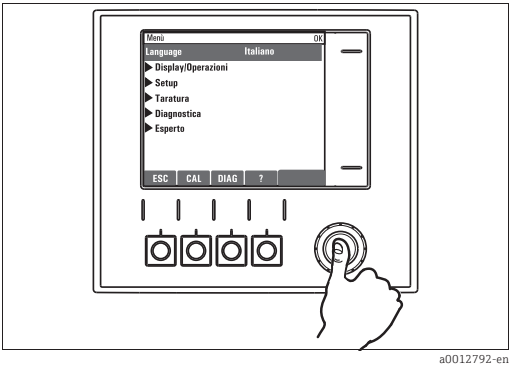

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Fig. 3: Pressing the navigator: launching a function

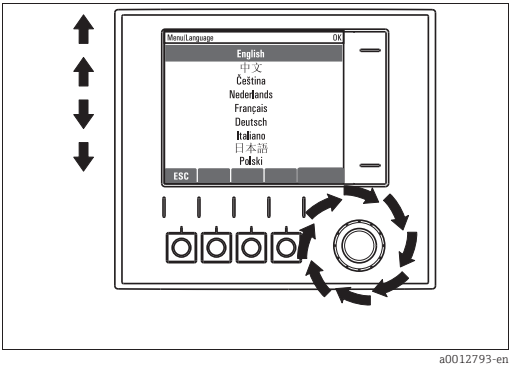

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Fig. 4: Turning the navigator: selecting a value (e.g. from a list)

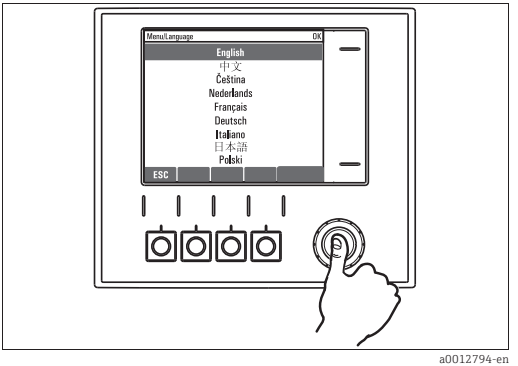

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Fig. 5: Pressing the navigator: accepting the new value

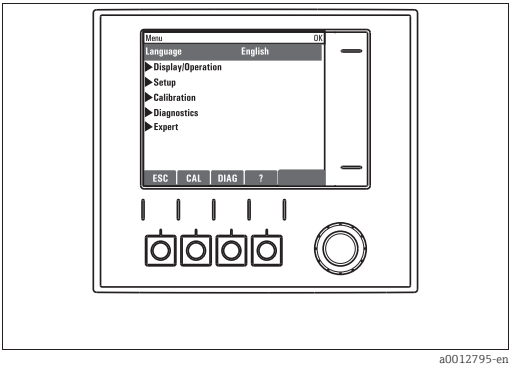

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Fig. 6: Result: new setting is accepted

Table of contents

1 About this manual

This manual gives a detailed account of all the configuration options **in the menu "Setup"**.

A description of the following menus is provided here:
- Inputs
  - Input configuration
  - Split into separate sections based on the different types of sensor that can be connected
- Outputs
  - Output configuration
  - Split into separate sections based on the different output types
- Additional functions
  - Settings for alarm sensors and controllers
  - Cleaning program configuration
  - Mathematical functions
- Data management
  - Firmware updates
  - Saving and loading configurations
  - Enter activation codes for extended functions

This manual does not include the following:
- Setup/General settings
  --> Operating Instructions "Commissioning", BA00444C (CM44x) or BA01225C (CM44xR)
- Display/Operation
  --> Operating Instructions "Commissioning", BA00444C (CM44x) or BA01225C (CM44xR)
- Calibration
  --> Operating Instructions "Calibration", BA00451C
- Diagnostics
  --> Operating Instructions "Maintenance & Diagnostics", BA00445C (CM44x) or BA01227C (CM44xR)
- Expert
  --> Internal Service Manual

2 General settings

2.1 Basic settings

Path: Menu/Setup/General settings

Function	Options	Info
Device tag	Customized text, 32 characters	Select any name for your controller. Use the TAG name for example.
Temperature unit	Options ▪ °C ▪ °F ▪ K **Factory setting** °C	
Current output range	Options ▪ 0 to 20 mA ▪ 4 to 20 mA **Factory setting** 4 to 20 mA	In accordance with Namur NE43, the linear range is from 3.8 to 20.5 mA (Current output range="4 to 20 mA") or from 0 to 20.5 mA (Current output range="0 to 20 mA"). If the range is exceeded or undershot, the current value stops at the range limit and a diagnostics message (460 or 461) is output.
Error current	0.0 to 23.0 mA **Factory setting** 21.5 mA	The function meets NAMUR NE43. Set the current value that should be output at the current outputs in the event of an error.
The value for "Error current" should be outside the measuring range. If you decided that your Current output range = "-0 to 20 mA", you should set an error current between 20.1 and 23 mA. If the Current output range = "4 to 20 mA" you could also define a value < 4 mA as the error current. The device allows an error current within the measuring range. In such instances pay attention to possible affects this may have on your process.		
Alarm delay	0 to 9999 s **Factory setting** 0 s	The system only displays the errors that are present longer than the set delay time. This makes it possible to suppress messages that only occur briefly and are caused by normal process-specific fluctuations.
Device Hold	Options ▪ Disabled ▪ Enabled **Factory setting** Disabled	You can activate an immediate, general hold here. The function acts in the same way as the "HOLD" soft key in the measuring menus.


Thermo
SCIENTIFIC
EQUIP # 07-10-25
RAMSEY
MICRO-TECH 9101

Micro-Tech™ 9101/9201 Integrator Reference Manual

REC 4281 Rev L

Part Number 127336—English

Thermo SCIENTIFIC

Revision History

Revision Number	Date Released	Eco Number	Details of the Release
Rev A	May 2012	2959	First release of the newly created *Micro-Tech 9101 Integrator/ 9105 Feeder Controller Reference Manual.*
Rev B	September 2012	3004	Updates.
Rev C	January 2013	3027	Corrections.
Rev D	February 2013	3044	On field wiring drawing, add “VDC ONLY” for motherboard pulse output.
Rev E	May 2013	3322	Corrected error on motherboard jumpers & Dual plant A/D jumpers. Removed 9105 information. Added 9201 information.
Rev F	September 2013	3363	Corrections.
Rev G	November 2013	3403	Corrections. Added descriptions to menu tables.
Rev H	May 2014	3459	New Software version 140.00.03.00. Rearranged and Aligned data tables. Added USB Print File naming section.
Rev J	July 2014	3488	New Software version 140.00.03.01. Corrections.
Rev K	January 2015	3796	New Software version 140.00.03.03. Corrections to the communication tables. Adding section on Multi-point calibration.
Rev L	August 2017	4269	New software version 140.00.04.05. Added scale code information A-5 line 60 and 61.

Software Version: 140.00.04.05

For future reference, write your belt-scale code below.

Micro-Tech belt-scale code = _____

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Important Safety Notices about Using the Micro-Tech

Please note carefully the following safety warnings and notices.

Safety in Transportation and Handling

The Micro-Tech is an integral part of your plant and when transporting, handling, and installing the unit, your own plant safety instructions must be applied. Because your Micro-Tech and associated systems are tailored to application requirements, it is impossible to be precise about product mass/weight. If precise values are required, the shipping crate will be marked with the overall shipping mass of the product and this may be used as a reasonable guideline.

Safe Practices During Use, Maintenance, and Repair

This manual contains details, as appropriate, including the appropriate tools. However, because of its importance, the warning contained in the installation section is repeated here.

TO GUARANTEE PERSONAL SAFETY, CARE MUST BE TAKEN WHEN WORKING ON OR AROUND THE MICRO-TECH. AS WITH ALL SUCH DEVICES THE MAIN SUPPLIES (ELECTRICAL AND OTHER) TO THE SYSTEM MUST BE LOCKED OFF WHEN PERFORMING REPAIR OR MAINTENANCE WORK. AFTER DISCONNECTING, SWITCH OFF AND LOCK THE ELECTRICAL SUPPLY.

Training Needs of Users

We offer all customers full training for operations and maintenance staff.

Low Voltage Directives

All of the recommendations for LVD apply to the prevention of electrical shock. If access to the electronics enclosure is required, the incoming AC power supply should be isolated remotely and locked-off. Access to the electronics enclosure by untrained personnel is not recommended.

Circuit Breaker

The Micro-Tech should be permanently connected to its AC supply. Please ensure that when installing the Micro-Tech, a switch or circuit breaker is used and is positioned close to the Micro-Tech in easy reach of the operator. The switch or circuit breaker shall be marked as the disconnecting device for the Micro-Tech.

DO NOT install the Micro-Tech in a position that makes it hard to use the AC mains isolator.

Thermo Fisher Scientific Warranty

The seller agrees, represents, and warrants that the equipment delivered hereunder shall be free from defects in material and workmanship. Such warranty shall not apply to accessories, parts, or material purchased by the

seller unless they are manufactured pursuant to seller's design, but shall apply to the workmanship incorporated in the installation of such items in the complete equipment. To the extent, purchased parts or accessories are covered by the manufacturer's warranty; seller shall extend such warranty to buyer. Seller's obligation under said warranty is conditioned upon the return of the defective equipment, transportation charges prepaid, to the seller's factory in Minneapolis, Minnesota, and the submission of reasonable proof to seller prior to return of the equipment that the defect is due to a matter embraced within seller's warranty hereunder. Any such defect in material and workmanship shall be presented to seller as soon as such alleged errors or defects are discovered by purchaser and seller is given opportunity to investigate and correct alleged errors or defects and in all cases, buyer must have notified seller thereof within one (1) year after delivery, or one (1) year after installation if the installation was accomplished by the seller.

Said warranty shall not apply if the equipment shall not have been operated and maintained in accordance with seller's written instructions applicable to such equipment, or if such equipment shall have been repaired or altered or modified without seller's approval; provided, however, that the foregoing limitation of warranty insofar as it relates to repairs, alterations, or modifications, shall not be applicable to routine preventive and corrective maintenance which normally occur in the operation of the equipment.

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About This Manual

This manual tells you how to install, operate, and troubleshoot the Micro-Tech. If you encounter a technical term or unit of measure that you do not recognize in the manual or in the Micro-Tech screens themselves, please consult the glossary at the end of the manual.

Conventions

The following conventions are used in this manual.

- The names of Micro-Tech buttons, functions, and so on are shown using initial upper-case letters—for example, Menu, Run, Edit, Choice, Tph (standard U.S. tons per hour), and so forth.

- *Italics* are used in the text for emphasis.

NOTE. Provides information of special importance. ▲

HINT. Indicates a hint about understanding or operating the Micro-Tech. ▲

Safety Precautions

Listed below are the safety messages for your Micro-Tech and its associated scale system. Please read all safety messages *very carefully*, because this information is important—for your own personal safety and the safety of others.

WARNING. Failure to observe could result in death or serious injury. ▲

CAUTION. Failure to observe may cause minor injury or damage to the equipment. ▲

Table of Contents

List of Figures

List of Tables

Chapter 1
Introduction

This manual provides the information you need to install, operate, and troubleshoot the Micro-Tech. Please read the entire manual before working with your Micro-Tech. For personal and system safety, and for the best product performance, make sure you thoroughly understand the manual before installing or using your Micro-Tech.

Unpacking the Micro-Tech

The Micro-Tech has been properly packaged for shipment at the factory. Please inspect all packages for damage *before* opening the shipping package, because the carrier is likely responsible for any damage. Once removed from the package, the Micro-Tech can be safely stored with its cover and latches secured and with the hole plugs installed. During storage, do not expose the Micro-Tech to moisture or to temperatures outside the range of –22 to +158°F (–30° to +70°C).

Overview of the Micro-Tech

The Micro-Tech Integrator is a microcomputer-driven instrument used for deriving rate and quantity of flowing material from signals representing the weight of a segment of moving material and its velocity. By processing, these two input signals, the Micro-Tech delivers visible and electrical outputs representing the rate of material movement as well as visible and electrical outputs representing the total amount of material that has passed the weighbridge.

For remote indicating, four options are available, as follows.

- Remote totalization.
- Remote flow rate, belt loading, or belt speed.
- Communications.
- Field Bus.

The Micro-Tech has provisions for four outputs on the digital output board, plus one DC output from the mother board—making a total of five, one of which can be defined as a Fault output. In addition, many automatic and check functions are available to monitor its calibration functions and maintenance schedule.

There are two models of Micro-Tech: the field-mounted version (**Figure 1–1**) and the panel-mounted version (**Figure 1–2**). For the panel-mounted version, provide a cut-out (see **Figure 1–2** for dimensions) in the panel and, after removing the holding brackets and installing the gasket, insert the Micro-Tech.

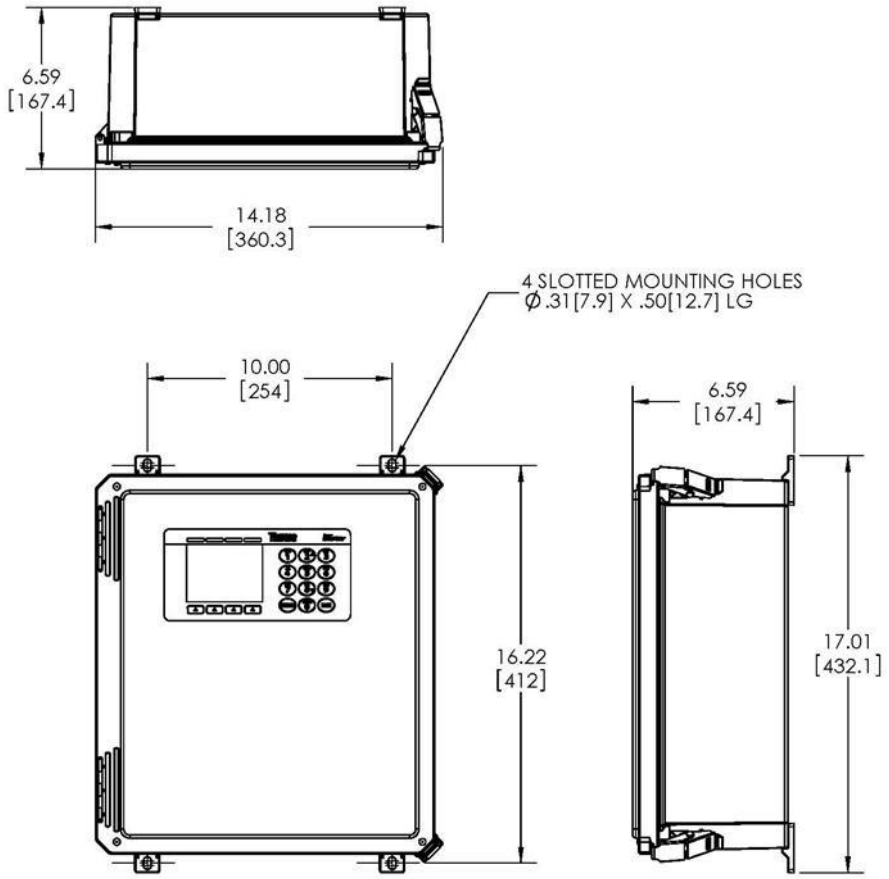

Figure 1–1. Field-Mounted Version of the Micro-Tech


RAMSEY
TECHNOLOGY INC.
501 - 90th Avenue N.W. • Minneapolis, MN 55433 • (612) 783-2500
SCALE
JUNCTION BOX

APPENDIX C

Operation and Maintenance

(including example work orders)

HEARTH TEMPERATURES

CHECK SCUBBER CHART AND TRENDING

SHUT DOWN OPERATIONS IF NOT RECORDING DATA

ALTERNATE ASH PUMPS WEEKLY

Date		1	2	3	4	5	6	7	8	9	10	TEMPERATURE		SCRUBBER		I.D.	SCRUBBER						BURNERS											TORQUE	THC ppm	Initial		
<6.75t/24hr												CS	Combustion	DRAFT	PRES	FAN %	619	648	642	Total Flow	P.H	B.H.															
	scale	tons											>1311/12hrs		>24.6"			<200	<95	<95	>755 /12hr	>6.5/3hrs	5,6,7	2	2	2	4	4	4	6	6	6	8	8	8	<100/month		Percent	Solids
23	.													.	.	%					.																
mid	.													.	.	%					.																
1	.													.	.	%					.																
2	.													.	.	%					.																
3	.													.	.	%					.																
4	.													.	.	%					.																
5	.													.	.	%					.																
6	.													.	.	%					.																
	TOTAL TONS-				% SOLIDS-			POLY-				DRY/TON-				GAS READING 2200-							GAS READING 0600-										TOTAL			Percent	Solids
7	.													.	.	%					.																
8	.													.	.	%					.																
9	.													.	.	%					.																
10	.													.	.	%					.																
11	.													.	.	%					.																
12	.													.	.	%					.																
13	.													.	.	%					.																
14	.													.	.	%					.																
	TOTAL TONS-				% SOLIDS-			POLY-				DRY/TON-				GAS READING 0600 -							GAS READING 1400-										TOTAL-			Percent	Solids
15	.													.	.	%					.																
16	.													.	.	%					.																
17	.													.	.	%					.																
18	.													.	.	%					.																
19	.													.	.	%					.																
20	.													.	.	%					.																
21	.													.	.	%					.																
22	.													.	.	%					.																
	TOTAL TONS-				% SOLIDS-			POLY-				DRY/TON-				GAS READING 1400-							GAS READING 2200-										TOTAL-				

Mid Lrg Gas

Mid Sm Gas

Mid Lrg

Sm

HEARTH TEMPERATURES | CHECK SCUBBER CHART AND TRENDING | ALTERNATE ASH PUMPS WEEKLY

SHUT DOWN OPERATIONS IF NOT RECORDING DATA

Date 6/15/22

			1	2	3	4	5	6	7	8	9	10	TEMPERATURE		SCRUBBER		I.D.	SCRUBBER						BURNERS										TORQUE	THC ppm	Initial	
			<6.75/24hr										CS	Combustion	DRAFT	PRES	FAN %	619	648	642	Total Flow	P.H	B.H.														
91.2	scale	tons												>1311/12hrs		>24.6"		<200	<95	<95	>755/12hr	>6.5/3hrs	5,6,7	2	2	2	4	4	4	6	6	6	8	8	8		<100/month		Percent Solids
23	96.2	5.0	843	1034	1040	1161	1525	1509	1360	911	293	133	243	1467	-.30	24.9	76.5%	143	76	73	900	6.3	5/6	Ø		Ø			43			100			7.1	52.1		
mid	101.3	10.1															%																					16.7%	
1	4.8	4.8	850	1029	1023	1396	1421	1465	1412	910	288	118	237	1430	-.30	25.0	76.5%	146	77	74	899	6.2	5/6	Ø		Ø			42			26			6.8	94.6		
2																	%																					17.1%	
3	15.1	5.2	865	1046	1029	1373	1402	1416	1399	913	272	122	238	1444	-.30	25.0	76.5%	146	77	74	901	6.3	5/6	Ø		2			100			79			7.1	44.7		
4																	%																					19.2%	17.8%
5	25.3	5.1	896	1110	1049	1488	1530	1513	1419	893	275	125	241	1443	-.30	24.9	76.5%	145	77	74	901	6.2	5/6	Ø		Ø			Ø			18			7.2	47.1		
6	30.1																%																					18.7%	

TOTAL TONS- 40.2 | % SOLIDS- 17.8% | POLY- 1428/1.4 | DRY/TON- 7.2 | GAS READING 2200- 388155 | GAS READING 0600- 388185 | TOTAL 30

																																							Percent Solids
7	34.8	4.6	378	1070	1036	1412	1403	1407	1397	909	287	121	234	1433	:30	24.9	76.5%	143	76	73	897	6.3	5/6	0		0			89			13			9.1	70	6.3	
(8)																	%																					12.74	17.7
(9)	44.0	5.5	860	1027	1041	1441	1477	1504	1429	924	296	116	241	1462	.30	24.6	76 %	143	73	72	944	6.3	5/6	6		0			0			100			7.5	58		10.99	17.0
(10)																	%																					13.02	18.0
11	55.1	5.5	876	1048	1034	1428	1466	1501	1468	983	307	121	241	1462	.30	24.9	76.5%	147	74	72	943	.	5/6	0		0			53			100			7.6	41			17.5
(12)			877	1059													%						0															14.83	16.8
13	66.3	5.5	877	1059	1037	1406	1400	1470	1440	817	244	121	244	1456	.30	25.0	76.5%	148	75	73	939	.	5/6	0		0			71			100			7.4	48			
14	71.7																%																							

TOTAL TONS- 41.8 | % SOLIDS- 17.5 | POLY- 17.7/1.7 | DRY/TON- 7.3 | GAS READING 0600 - 388185 | GAS READING 1400- 387221 | TOTAL 36

																																							Percent Solids
15	77.2	5.0	876	1065	1037	1553	1403	1420	1387	577	252	134	242	1457	-.29	25.1	76.5%	147	80	75	886	6.3	5/6	0		0			46			17			8	39		15.9	
16																	%																								
17	87.0	4.7	901	1109	1053	1416	1461	1447	1403	874	282	131	244	1437	-.3	24.9	76.5%	146	80	76	897	6.3	5/6	0		0			100			41			7	38			
18																	%																								
19	96.2	4.9	915	1113	1071	1431	1513	1485	1323	876	286	128	249	1444	-.3	24.8	76.5%	143	78	75	887	6.4	5/6	0		0			96			35			7	23			15.9
20																	%																					15.9		
21	106.0	4.8	944	1128	1071	1374	1403	1257	1307	874	281	137	245	1438	-.29	25.0	76.5%	145	80	75	880	6.3	5/6	0		1W			1W			1W			7	33			
22	110.8																%																								

TOTAL TONS- 38.9 | % SOLIDS- 15.9 | POLY- 1648/1.6 | DRY/TON- 6.2 | GAS READING 1400- 388221 | GAS READING 2200- 388260 TOTAL 39

Mid Lrg Gas 538807

Mid Sm Gas 324443

Mid Lrg 539036

Mid Sm 324470

17.1%

DATE		23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Blnd tank
	SLUDGE FLOW																									1 2 3
	GBT BELT SPEED																									1 2 3
	POLY PUMP #	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
	GBT. TOP																									1 2 3
S	BELLOWS HEIGHT																									1 2 3
G	PLI																									1 2 3
B	BP BELT SPEED																									1 2 3
T	BELT PRES. TOP																									1 2 3
1	BELLOWS HEIGHT																									Days
2	PLI																									1 2 3
3	BP Bottom Pres.																									1 2 3
	BELLOWS HEIGHT																									1 2 3
	PLI																									1 2 3
	CAKE THICKNESS	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	1 2 3
																										1 2 3
	SLUDGE FLOW																									1 2 3
	GBT BELT SPEED																									1 2 3
	POLY PUMP #	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	Afternoon
S	GBT PRES. TOP																									1 2 3
G	BELLOWS HEIGHT																									1 2 3
B	PLI																									1 2 3
T	BELT SPEED																									1 2 3
1	BELT PRES. TOP																									1 2 3
2	BELLOWS HEIGHT																									1 2 3
3	PLI																									1 2 3
	BP Bottom Pres.																									1 2 3
	BELLOWS HEIGHT																									
	PLI																									
	CAKE THICKNESS	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	

Midnight

	POLY #1 Totalizer	POLY #2 Totalizer	POLY #3 Totalizer	
22:00				
Mid				
6:00				
total				

X

Days

	POLY #1 Totalizer	POLY #2 Totalizer	POLY #3 Totalizer	
6:00				
14:00				
total				

X

Afternoon

	POLY #1 Totalizer	POLY #2 Totalizer	POLY #3 Totalizer	
14:00				
22:00				
total				

X

Ferric Feed System

Pump Runnning: Mid - 1 2 3 ____% Day- 1 2 3 ____% Aft- 1 2 3 ____%

Ferric Flow Rate: Mid - ____ gpd Day ____gpd Aft - _____gpd

Check For Leaks

Weekly (Weekend) - Maintenance Checklist

	DATE	DATE	DATE	DATE	DATE	DATE
First day Clean - Up						
Long Incline	**M**	**A**	**D**	**M**	**A**	**D**
Short Incline	**M**	**A**	**D**	**M**	**A**	**D**
Clean under Belt #3	**M**	**A**	**D**	**M**	**A**	**D**
Flush Trench behind Belt Presses	**M**	**A**	**D**	**M**	**A**	**D**
Steam Clean BP #	**D**	**M**	**A**	**D**	**M**	**A**
Clean push water screens polymer and ferric	**D**	**M**	**A**	**D**	**M**	**A**
Empty Trash in Solids Bldg	**D**	**M**	**A**	**D**	**M**	**A**
Clean Top of MHF + Penthouse	**A**	**D**	**M**	**A**	**D**	**M**
Check oil level Conveyor drives #3,#4,#6 30 WT Oil.	**A**	**D**	**M**	**A**	**D**	**M**
Steam Clean BP #	**A**	**D**	**M**	**A**	**D**	**M**
Second day Clean - Up						
Clean and Switch Screens for Venturi pumps, circle what side is in service on	**L R**	**L R**	**L R**	**L R**	**L R**	**L R**
Pump Skid (Main Floor of MHF)	**A**	**D**	**M**	**A**	**D**	**M**
Clean Scrubber Water Screens(MHF basemt.) or steam clean GBTs	**M**	**A: steam one GBT#**	**D**	**M: steam one GBT#**	**A**	**D: steam one GBT#**
Empty penthouse wheelbarrow - hose area	**D**	**M**	**A**	**D**	**M**	**A**
Ash hopper	**D**	**M**	**A**	**D**	**M**	**A**
Clean U.V system cone screen	D	**A**	**D**	**A**	**D**	**A**
Warm up MHF, do NOT fill BTs yet (for MIDs)	**A**	**A**	**A**	**A**	**A**	**A**
Fill and mix Polymer Tanks	**A**	**A**	**A**	**A**	**A**	**A**
Ensure BFP/ Scrubber/ OCS fan is ready	**A**	**A**	**A**	**A**	**A**	**A**
Check water softener, add salt (# of bags)	**A ( )**	**M ( )**	**D ( )**	**A ( )**	**M ( )**	**D ( )**
All Shifts Dewater Storage Tanks						
Tighten chicanes on GBT's	**D**	**A**	**M**	**D**	**A**	**M**
Grease ID fan bearings (2) - 2 x w. black grease gun (shows ID fan bearings) **every 2 weeks**	**D**	**A**	**M**	**D**	**A**	**M**

WO# 50312.01 **Type** Corrective **Priority** High

Create Reason Manually Created **Created By** Dweier

Equipment 08-05 INC SCRUBBER SYSTEM

Location J INCINERATOR BLDG

Task CORRECTIVE MAINTENANCE

Created	8/20/2021
Printed	
Scheduled	8/20/2021
Delinquent	
Completed	8/27/2021

Shutdown

Startup

Downtime Hours

Instructions

All scrubber boxes/readings are wire framed. Some of the readings for the MHF are wire framed. Had a small power glitch at 22:45 on 8/19/20 that may have caused the communication to go down.

Comments JT or DH repaired issue

Work Order Total

WO# 21177.01 **Type** Unscheduled **Priority** High

Create Reason Manually Created **Created By** dhenrikson

Equipment 08-07-43 INC INST PH PROBE (AIT-825)

Location J INCINERATOR BLDG

Task CORRECTIVE MAINTENANCE

Created	2/23/2021
Printed	
Scheduled	2/23/2021
Delinquent	
Completed	2/25/2021

Shutdown

Startup

Downtime Hours

Instructions

Calibrate the scrubber ph sensor. it appears to be reading too low.

Comments

2/24/21-DH- Replaced the ph probe/sensor in the scrubber water line. Got LY from lab and we calibrated the new probe, the calibration went relly good sensor very resposive. Placed the senso back into the process water, it was reading 6.2 ph right away on scada. This was around 8:45-9:00. Ran an grab sample through the lab at just around 9:00 and that sample was reading 6.208ph on the labs ph monitor.

7.0 ph buffer read 7.12ph -117mV
4.0 ph buffer read 4.13ph 56mV
Slope was 58.52 mV

At around 1:40 performed another grab sample comparison. SCADA 6.4, and the grab analysis showed 6.38. At this point the sensor itself is actually very accurate.

2/23/21-DH- Worked with Larry from the Lab showing him how to do the calibration on the scrubber ph probe. Removed the probe from the process water. Cleaned the probe with DI water and wiped the housing dry, without touching the sensor tip. Performed the 2 point calibration using buffer sollution 7.0 and 4.0 ph. rinsed and cleaned the sensor before placing it back into the process water. After about 2-3 hours it has stabilized at 6.0-6.1 ph. Also performed 2 grab samples at 11:00 and 1:00 they were 6.454 and 6.511 ph respectively. At this point it is setermoned to be a malfunctioning sensor and I will replace it tomorrow morning.

Work Order Labor

Labor Class	Labor Account No	Employee	Est. Hours	Actual Hours	Cost
CONTRACTOR	WWTP-ELECTRICAL	Henrikson		8.00	$0.00
LAB	WWTP-LAB	Young			$0.00
Labor Total					$0.00

Work Order Total

Report Totals	**Downtime Hours**	0	**Part Cost**	$0.00
			Labor Cost	$0.00
			Vendor Cost	$0.00
			Tool/Equip Cost	$0.00
			Total Cost	$0.00

pH in Scrubber Water

Todd Schaedig <tschaedig@cityofwarren.org>

Wed 2/24/2021 9:35 AM

To: WWTP_Operations <WWTP_Operations@cityofwarren.org>; Andrew Hayman <ahayman@cityofwarren.org>
Cc: Donna Dordeski <ddordeski@cityofwarren.org>

The pH probe was changed out this morning and calibrated.

After calibration Doug checked a grab sample of the scrubber drain water and had the pH run in the lab. The probe now matches the lab results.

The question I am posing is why is our scrubber water pH level in the 6.0's We normally run in the mid to upper 6.0's while operating.

What is going on in the plant over the last couple of days that would cause our cake quality to change in a way that we are removing more acid from the scrubber air stream? I have usually seen this happen in the past if we get into a septic sludge storage tank situation.

All thoughts and theories are welcome.

Todd S. Schaedig, P.E.
Facilities Engineer
City of Warren Waste Water Treatment Plant
(586) 264-2530 #8203

Re: pH Probe Calibration

Douglas Henrikson <dhenrikson@cityofwarren.org>
Tue 2/23/2021 1:56 PM
To: Andrew Hayman <ahayman@cityofwarren.org>; Todd Schaedig <tschaedig@cityofwarren.org>

Todd,

After researching the scrubber ph probe. Joe L did in fact change the probe in November of 2019. I will as we discussed move forward with replacing the sensor tomorrow morning because it is still only reading 6.0-6.1.

I have done 2 grab samples today

11:15- It was 6.454
about 1:15- It was 6.551

Scada was showing 6.1 at the time of both grab samples.

Doug Henrikson

WWTP Electrician
Warren Waste Water Treatment
(586) 264-2530 ext. 8414

From: Andrew Hayman <ahayman@cityofwarren.org>
Sent: Tuesday, February 23, 2021 7:40 AM
To: Todd Schaedig <tschaedig@cityofwarren.org>; Douglas Henrikson <dhenrikson@cityofwarren.org>
Subject: Re: pH Probe Calibration

I'll try to get to it. Isn't it quarterly maintenance?

Andrew Hayman
Lab Director
City of Warren, Wastewater Treatment Plant
586.264.2530 x8113

From: Todd Schaedig <tschaedig@cityofwarren.org>
Sent: Tuesday, February 23, 2021 7:38 AM
To: Andrew Hayman <ahayman@cityofwarren.org>; Douglas Henrikson <dhenrikson@cityofwarren.org>
Subject: pH Probe Calibration

Gents - when was the last time the pH probe was calibrated?

From antero it looks like it was done on 12/8/20.

WO# 11090.01 **Type** Corrective **Priority** Low

Create Reason Manually Created **Created By** tschaedig

Equipment 08-05 INC SCRUBBER SYSTEM

Location J INCINERATOR BLDG

Task CORRECTIVE MAINTENANCE

Created	1/27/2021
Printed	
Scheduled	1/27/2021
Delinquent	2/6/2021
Completed	2/1/2021

Shutdown

Startup

Downtime Hours

Instructions

Install new pressure gauges on the supply lines for the scrubber lances.

TS already purchased the gauges.

Purge the ports clean before installing the new gauges.

Comments 01/29/2021 ST SS
purged line put new gauges in

Work Order Labor

Labor Class	Labor Account No	Employee	Est. Hours	Actual Hours	Cost
MAINTENANCE	001 AllMax	Turner		1.00	$25.00
Labor Total					$25.00

Work Order Total

WO# 10873.01 **Type** Corrective **Priority** High

Create Reason Manually Created **Created By** tschaedig

Equipment 08-05-03 INC ID FAN SCRUBBER SYS

Location J INCINERATOR BLDG

Task CORRECTIVE MAINTENANCE

Created	5/22/2020
Printed	
Scheduled	5/22/2020
Delinquent	5/22/2020
Completed	5/26/2020

Shutdown

Startup

Downtime Hours

Instructions

Repair leaking 1/2" ball valve for missing pressure gauge on upper high pressure venturi tube water supply lance. Pressure gauge has been removed for replacement. Isoloation valve is blowing water in closed position. This is not on the ID Fan it is on the scrubber.
See Todd for more information.

Comments 5/22/20 RH/ST Removed faulty ball valve. Went to Macomb group to try and get replacement. They didnt have any exact match to the one we have. Got a brass valve as a temporary replacement. Installed the brass valve.

Work Order Labor

Labor Class	Labor Account No	Employee	Est. Hours	Actual Hours	Cost
MAINTENANCE	WWTP-MAINTENANCE	Turner		1.50	$37.50
MAINTENANCE	WWTP-MAINTENANCE	Hilliard		1.50	$37.50
Labor Total					$75.00

Work Order Total

WO# 10868.01 **Type** Corrective **Priority** High

Create Reason Manually Created **Created By** tschaedig

Equipment 08-05 INC SCRUBBER SYSTEM

Location J INCINERATOR BLDG

Task CORRECTIVE MAINTENANCE

Created	5/14/2020
Printed	
Scheduled	5/14/2020
Delinquent	5/19/2020
Completed	5/18/2020

Shutdown

Startup

Downtime Hours

Instructions

Repair threads on Venturi throat manifold water screen fitting. Fitting is on the second floor of the scrubber on the high pressure system. (it is wrapped in caution tape).

When performing the scrubber inspection earlier this week it was noted that the screen plug was very difficult to remove. Once removed it was found that the threads on the male and female part of the fitting were damaged. WF did his best to repair the male threads but still could not get the screen plug to seat all the way into the fitting.

We believe the fitting is 1.5" dia with number 14 threads and is stainless steel. Please try to repair the female threads and get the plug to seat all the way and seal.

Picture attached to WO as well.

Comments 05/15/2020 ST
cleaned and filed threads on plug manifold screen and replaced new sreen and cleaned interior threads

Work Order Labor

Labor Class	Labor Account No	Employee	Est. Hours	Actual Hours	Cost
MAINTENANCE	WWTP-MAINTENANCE	Turner		3.00	$75.00
Labor Total					$75.00

Work Order Total

WO# 40066.01 **Type** Scheduled **Priority** High

Create Reason Manually Created **Created By** tschaedig

Equipment 08-05 INC SCRUBBER SYSTEM

Location J INCINERATOR BLDG

Task PM ANNUAL Annual General PM

Created	5/11/2020
Printed	
Scheduled	5/11/2020
Delinquent	5/21/2020
Completed	7/17/2020

Shutdown

Startup

Downtime Hours

Instructions

Perform annual incinerator inspection.
Scheduled for 5/12/20

Comments On 5/12/20 TS, WF and LY performed the annual scrubber inspection. Shut down, opened up and went through the entire interior of the unit. Inspection report to be attached when completed by TS.

Needed 5 high pressure manual gauges replaced. TS ordered them on 6/29/20. (High pressure lances)

Inspection report attached.

Work Order Total

WO# 40042.01 **Type** Scheduled **Priority** High

Create Reason Manually Created **Created By** tschaedig

Equipment 08-05 INC SCRUBBER SYSTEM

Location J INCINERATOR BLDG

Task PM ANNUAL Annual General PM

Created	5/17/2019
Printed	5/21/2019
Scheduled	5/17/2019
Delinquent	5/17/2019
Completed	5/24/2019

Shutdown

Startup

Downtime Hours

Instructions

Perform permit required annual inspection of Scrubber System.

Refer to attached document for inspection procedure.

Comments 5/14/19 Dan Brady and William Forester cleaned all strainers on the scrubber.

5/15/19 Dan Brady and Todd Schaedig opened up entire scrubber and inspected the interior from top to bottom, inspected all viewable nozzles and spray patterns. Inspected operation of MD-5. Looked for potential draft leaks. Two local pressure gauges need to be replaced on the lances.

05-20-19 Joe Lalama Two bad gauges were replaced today, and also noticed that ther were three (3) other bad gauges also (will order fron Grainger asap).

05-23-19 Joe Lalama Received the other three (3) gauges from Grainger yesterday, and today I installed them. Job compleated ..

Work Order Total

WO# 20086.01 **Type** Corrective **Priority** High

Create Reason Manually Created **Created By** bbaumgartner

Equipment 08-05 INC SCRUBBER SYSTEM

Location J INCINERATOR BLDG

Task CORRECTIVE MAINTENANCE

Created	7/12/2018
Printed	
Scheduled	7/12/2018
Delinquent	7/13/2018
Completed	7/16/2018

Shutdown

Startup

Downtime Hours

Instructions

MHF scrubber control screen locked up with error message. Could not reset. No scrubber adjustment possible. Very close to permit violation if not repaired.

Comments BC-Pulled 24 volt power off of monitor allowed monitor to reset. It is now functional again

Work Order Labor

Labor Class	Labor Account No	Employee	Est. Hours	Actual Hours	Cost
ELECTRICAL	WWTP-ELECTRICAL	Clor	0.50		$0.00
Labor Total					$0.00

Work Order Total

APPENDIX D

Equipment Calibration / Performance Evaluation Examples

Work Order Number
30914.01

Work Order

Delinquent Reprint

INSTRUMENTATION

Work Order Type	Scheduled
Reason Created	Triggered by Calendar
Priority	
Labor Class	
Employee	

Date Scheduled	1/4/2021	**Date Completed**
Date Delinquent	2/3/2021	
Date Last Completed	1/23/2020	
Interval Days	0	
Date Printed	5/19/2021	

Equipment No 08-07-14 INC INST INCIN TEMP LEVEL 5
Location J INCINERATOR BLDG
Task Description INST ANNU Instrumentation Annual PM
Task Instructions Annual PM for Instrumentation Personnel
Verification of T-couple (08-07-14)

for hearth # 5 front

**** This sensor is a K-Type T-couple.******

Shutdown
Startup

NOTE:

Do not disconnect any wires from the thermocouple or transmitter, without speaking to operations first.

May need to remove and inspect the thermocouple as well.

1) Using the Fluke 714 t-couple calibration meter verify the temperature on thermocouple with the temp on SCADA.. Read across the red and yellow wires from temp probe. Temps should be within +/- 5 degrees on meter to SCADA.

2) If temps are further off than 5 degrees go to the Incinerator control panel and use the Loop calibrator to source 4 mA into Laurel transmitter while using second meter to measure output mA from Laurel transmitter, do the same sourcing 20 mA and measuring output.

3) If the outputs on the Laurel Transmitter are off you will need to source 4mA in and adjust zero to match at 4mA out, then source 20mA in and adjust span to match at 20mA. (this process may need to be repated, when you adjust the span it will affect the zero).

4) After the Laurel Transmitter has been calibrated, or verified. Go back to thermocouple and disconnect output wires. Then source 4,8,12,16,20 mA through the cable and confirm the temperatures to the scaling provided. After verifying the temperature scaling wire the thermocouple back up and return to service.

NOTE:

The PLC computer scaling for this unit is:

4 ma = 32 deg F
8 ma = 599 deg F
12 ma = 1,166 deg F
16 ma = 1,733 deg F
20 ma = 2,300 deg F

Equipment Comments INCINERATOR TEMPERATURE FOR LEVEL #5
K-TYPE THERMOCOUPLE
TEMERATURE MEASURE
2ND FLOOR INCINERATOR FRONT

Work Order Labor

Labor Class	Labor Account No	Employee	Estimated Hours	Actual Hours
ELECTRICAL	WWTP-ELECTRICAL	Henrikson	1.00	2.50

Notes

Work Order

Delinquent Reprint

INSTRUMENTATION

Created By ahayman **Signature**


LEVEL # 4 ON SCADA
EQUIP #08-07-16
CALIBRATION
ID No. 08-07-16
By DH Date 6/30/2021
Due 6/30/2022
ISO 9001 REGISTERED
JMS
SOUTHEAST INCORPORATED
1-800-873-1835


CALIBRATION
LEVEL # 5 ON SCADA
EQUIP #08-07-14


CALIBRATION
I.D.No 08-07-13
By DH
DUE 6/2022
LEVEL # 6 ON SCADA
EQUIP #08-07-13

Flowmeter Verification Certificate Transmitter

City of Warren	Warren WWTP
Customer	Plant
50W80-ULGA1AC2BABW	QUENCH
Order code	Tag Name
PROMAG 50 W DN80	1.0084 - 1.0084
Device type	K-Factor
KC084E16000	-17
Serial number	Zero point
V2.04.00	V1.04.10
Software Version Transmitter	Software Version I/O-Module
05/13/2021	09:30 AM
Verification date	Verification time

Verification result Transmitter: Passed

Test item	Result	Applied Limits
Amplifier	Passed	Basis: 0.55 %
Current Output 1	Passed	0.05 mA
Test Sensor	Passed	

FieldCheck Details	**Simubox Details**
198082	248598
Production number	Production number
1.07.10	1.00.02
Software Version	Software Version
12/2020	12/2020
Last Calibration Date	Last Calibration Date

Date Operator's Sign Inspector's Sign

Overall results:

The achieved test results show that the instrumment is completely functional, and the measuring results lie within +/- 1% of the original calibration. [1)]

The calibration of the Fieldcheck test system is fully traceable to national standards.

1) Prerequisite is an additional proof of electrode integrity with a high voltage test.

Endress+Hauser
People for Process Automation

FieldCheck - Result Tab Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W80-ULGA1AC2BABW**	Tag Name	**QUENCH**
Device type	**PROMAG 50 W DN80**	K-Factor	**1.0084 - 1.0084**
Serial number	**KC084E16000**	Zero point	**-17**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:30 AM**

Verification Flow end value (100 %): 318.690 gal/m
Flow speed 4.00 m/s

Passed / Failed	Test item	Simul. Signal	Limit Value	Deviation
	Test Transmitter			
✓	Amplifier	15.934 gal/m (5%)	1.50 %	0.61 %
✓		79.672 gal/m (25.0%)	0.70 %	0.05 %
✓		159.345 gal/m (50.0%)	0.60 %	0.08 %
✓		318.690 gal/m (100%)	0.55 %	0.02 %
✓	Current Output 1	4.000 mA (0%)	0.05 mA	0.002 mA
✓		4.800 mA (5%)	0.05 mA	0.000 mA
✓		8.000 mA (25.0%)	0.05 mA	-0.018 mA
✓		12.000 mA (50.0%)	0.05 mA	0.002 mA
✓		20.000 mA (100%)	0.05 mA	0.006 mA
		Start value	**Limits range**	**Measured value**
	Test Sensor			
✓	Coil Curr. Rise	4.200 ms	0.000..12.650 ms	5.167 ms
✓	Coil Curr. Stability		---	---
✓	Electrode Integrity	mV	0.0..300.000 mV	3.262 mV

Legend of symbols

✓	✗	–	?	!
Passed	Failed	not tested	not testable	Attention

FieldCheck: Parameters Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W80-ULGA1AC2BABW**	Tag Name	**QUENCH**
Device type	**PROMAG 50 W DN80**	K-Factor	**1.0084 - 1.0084**
Serial number	**KC084E16000**	Zero point	**-17**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:30 AM**

Curent Output	Assign	Current Range	Value 0_4mA	Value 20 mA		
Terminal 26/27	VOLUME FLOW	4-20 mA Passive	0.0 gal/m	400.00 gal/m		

Actual System Ident. 125.0

Flowmeter Verification Certificate Transmitter

City of Warren	Warren WWTP
Customer	Plant
50W1H-ULGA1AC2BABW	IMP TRAY
Order code	Tag Name
PROMAG 50 W DN100	1.3057 - 1.3057
Device type	K-Factor
KC085916000	-13
Serial number	Zero point
V2.04.00	V1.04.10
Software Version Transmitter	Software Version I/O-Module
05/13/2021	09:42 AM
Verification date	Verification time

Verification result Transmitter: Passed

Test item	Result	Applied Limits
Amplifier	Passed	Basis: 0.55 %
Current Output 1	Passed	0.05 mA
Test Sensor	Passed	

FieldCheck Details	**Simubox Details**
198082	248598
Production number	Production number
1.07.10	1.00.02
Software Version	Software Version
12/2020	12/2020
Last Calibration Date	Last Calibration Date

Date Operator's Sign Inspector's Sign

Overall results:

The achieved test results show that the instrumment is completely functional, and the measuring results lie within +/- 1% of the original calibration. [1)]

The calibration of the Fieldcheck test system is fully traceable to national standards.

1) Prerequisite is an additional proof of electrode integrity with a high voltage test.

Endress+Hauser
People for Process Automation

FieldCheck - Result Tab Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W1H-ULGA1AC2BABW**	Tag Name	**IMP TRAY**
Device type	**PROMAG 50 W DN100**	K-Factor	**1.3057 - 1.3057**
Serial number	**KC085916000**	Zero point	**-13**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:42 AM**

Verification Flow end value (100 %): 497.953 gal/m
Flow speed 4.00 m/s

Passed / Failed	Test item	Simul. Signal	Limit Value	Deviation
	Test Transmitter			
✓	Amplifier	24.898 gal/m (5%)	1.50 %	0.51 %
✓		124.488 gal/m (25.0%)	0.70 %	0.04 %
✓		248.976 gal/m (50.0%)	0.60 %	0.05 %
✓		497.953 gal/m (100%)	0.55 %	-0.01 %
✓	Current Output 1	4.000 mA (0%)	0.05 mA	0.002 mA
✓		4.800 mA (5%)	0.05 mA	0.001 mA
✓		8.000 mA (25.0%)	0.05 mA	-0.019 mA
✓		12.000 mA (50.0%)	0.05 mA	0.003 mA
✓		20.000 mA (100%)	0.05 mA	0.009 mA
		Start value	**Limits range**	**Measured value**
	Test Sensor			
✓	Coil Curr. Rise	5.000 ms	0.000..14.250 ms	6.252 ms
✓	Coil Curr. Stability		---	---
✓	Electrode Integrity	mV	0.0..300.000 mV	3.297 mV

Legend of symbols

✓	✗	–	?	!
Passed	Failed	not tested	not testable	Attention

FieldCheck: Parameters Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W1H-ULGA1AC2BABW**	Tag Name	**IMP TRAY**
Device type	**PROMAG 50 W DN100**	K-Factor	**1.3057 - 1.3057**
Serial number	**KC085916000**	Zero point	**-13**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:42 AM**

Curent Output	Assign	Current Range	Value 0_4mA	Value 20 mA		
Terminal 26/27	VOLUME FLOW	4-20 mA Passive	0.0 gal/m	1000.00 gal/m		

Actual System Ident. 125.0

Flowmeter Verification Certificate Transmitter

City of Warren	Warren WWTP
Customer	Plant
50W40-UMGA1AC2BABW	V INLET
Order code	Tag Name
PROMAG 50 W DN40	0.7279 - 0.7279
Device type	K-Factor
KC084516000	-23
Serial number	Zero point
V2.04.00	V1.04.10
Software Version Transmitter	Software Version I/O-Module
05/13/2021	09:57 AM
Verification date	Verification time

Verification result Transmitter: Passed

Test item	Result	Applied Limits
Amplifier	Passed	Basis: 0.55 %
Current Output 1	Passed	0.05 mA
Test Sensor	Passed	

FieldCheck Details	**Simubox Details**
198082	248598
Production number	Production number
1.07.10	1.00.02
Software Version	Software Version
12/2020	12/2020
Last Calibration Date	Last Calibration Date

Date Operator's Sign Inspector's Sign

Overall results:

The achieved test results show that the instrumment is completely functional, and the measuring results lie within +/- 1% of the original calibration. [1)]

The calibration of the Fieldcheck test system is fully traceable to national standards.

1) Prerequisite is an additional proof of electrode integrity with a high voltage test.

Endress+Hauser
People for Process Automation

FieldCheck - Result Tab Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W40-UMGA1AC2BABW**	Tag Name	**V INLET**
Device type	**PROMAG 50 W DN40**	K-Factor	**0.7279 - 0.7279**
Serial number	**KC084516000**	Zero point	**-23**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:57 AM**

Verification Flow end value (100 %): 79.672 gal/m
Flow speed 4.00 m/s

Passed / Failed	Test item	Simul. Signal	Limit Value	Deviation
	Test Transmitter			
✓	Amplifier	3.984 gal/m (5%)	1.50 %	0.62 %
✓		19.918 gal/m (25.0%)	0.70 %	0.06 %
✓		39.836 gal/m (50.0%)	0.60 %	-0.01 %
✓		79.672 gal/m (100%)	0.55 %	-0.02 %
✓	Current Output 1	4.000 mA (0%)	0.05 mA	0.000 mA
✓		4.800 mA (5%)	0.05 mA	0.001 mA
✓		8.000 mA (25.0%)	0.05 mA	-0.022 mA
✓		12.000 mA (50.0%)	0.05 mA	0.001 mA
✓		20.000 mA (100%)	0.05 mA	0.005 mA
		Start value	**Limits range**	**Measured value**
	Test Sensor			
✓	Coil Curr. Rise	3.200 ms	0.000..10.200 ms	3.949 ms
✓	Coil Curr. Stability		---	---
✓	Electrode Integrity	mV	0.0..300.000 mV	0.000 mV

Legend of symbols

✓	✗	–	?	!
Passed	Failed	not tested	not testable	Attention

FieldCheck: Parameters Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W40-UMGA1AC2BABW**	Tag Name	**V INLET**
Device type	**PROMAG 50 W DN40**	K-Factor	**0.7279 - 0.7279**
Serial number	**KC084516000**	Zero point	**-23**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:57 AM**

Curent Output	Assign	Current Range	Value 0_4mA	Value 20 mA		
Terminal 26/27	VOLUME FLOW	4-20 mA Passive	0.0 gal/m	120.00 gal/m		

Actual System Ident. 127.0

Flowmeter Verification Certificate Transmitter

City of Warren	Warren WWTP
Customer	Plant
50W40-ULGA1AC2BABW	V THROAT
Order code	Tag Name
PROMAG 50 W DN40	0.7141 - 0.7141
Device type	K-Factor
KC084416000	-18
Serial number	Zero point
V2.04.00	V1.04.10
Software Version Transmitter	Software Version I/O-Module
05/13/2021	09:49 AM
Verification date	Verification time

Verification result Transmitter: Passed

Test item	Result	Applied Limits
Amplifier	Passed	Basis: 0.55 %
Current Output 1	Passed	0.05 mA
Test Sensor	Passed	

FieldCheck Details	Simubox Details
198082	248598
Production number	Production number
1.07.10	1.00.02
Software Version	Software Version
12/2020	12/2020
Last Calibration Date	Last Calibration Date

Date Operator's Sign Inspector's Sign

Overall results:

The achieved test results show that the instrumment is completely functional, and the measuring results lie within +/- 1% of the original calibration. [1)]

The calibration of the Fieldcheck test system is fully traceable to national standards.

1) Prerequisite is an additional proof of electrode integrity with a high voltage test.

FieldCheck - Result Tab Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W40-ULGA1AC2BABW**	Tag Name	**V THROAT**
Device type	**PROMAG 50 W DN40**	K-Factor	**0.7141 - 0.7141**
Serial number	**KC084416000**	Zero point	**-18**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:49 AM**

Verification Flow end value (100 %): 79.672 gal/m
Flow speed 4.00 m/s

Passed / Failed	Test item	Simul. Signal	Limit Value	Deviation
	Test Transmitter			
✓	Amplifier	3.984 gal/m (5%)	1.50 %	0.64 %
✓		19.918 gal/m (25.0%)	0.70 %	0.07 %
✓		39.836 gal/m (50.0%)	0.60 %	0.01 %
✓		79.672 gal/m (100%)	0.55 %	0.00 %
✓	Current Output 1	4.000 mA (0%)	0.05 mA	0.000 mA
✓		4.800 mA (5%)	0.05 mA	-0.001 mA
✓		8.000 mA (25.0%)	0.05 mA	-0.023 mA
✓		12.000 mA (50.0%)	0.05 mA	-0.001 mA
✓		20.000 mA (100%)	0.05 mA	0.002 mA
		Start value	**Limits range**	**Measured value**
	Test Sensor			
✓	Coil Curr. Rise	3.200 ms	0.000..10.200 ms	3.862 ms
✓	Coil Curr. Stability		---	---
✓	Electrode Integrity	mV	0.0..300.000 mV	3.261 mV

Legend of symbols

✓	✗	–	?	!
Passed	Failed	not tested	not testable	Attention

FieldCheck: Parameters Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W40-ULGA1AC2BABW**	Tag Name	**V THROAT**
Device type	**PROMAG 50 W DN40**	K-Factor	**0.7141 - 0.7141**
Serial number	**KC084416000**	Zero point	**-18**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:49 AM**

Curent Output	Assign	Current Range	Value 0_4mA	Value 20 mA		
Terminal 26/27	VOLUME FLOW	4-20 mA Passive	0.0 gal/m	120.00 gal/m		

Actual System Ident. 127.0

Flowmeter Verification Certificate Transmitter

City of Warren	Warren WWTP
Customer	Plant
50W25-ULGA1AC2BABW	ME FLOWS
Order code	Tag Name
PROMAG 50 W DN25	0.7086 - 0.7086
Device type	K-Factor
KC080316000	-29
Serial number	Zero point
V2.04.00	V1.04.10
Software Version Transmitter	Software Version I/O-Module
05/13/2021	09:19 AM
Verification date	Verification time

Verification result Transmitter: Passed

Test item	Result	Applied Limits
Amplifier	Passed	Basis: 0.55 %
Current Output 1	Passed	0.05 mA
Test Sensor	Passed	

FieldCheck Details	Simubox Details
198082	248598
Production number	Production number
1.07.10	1.00.02
Software Version	Software Version
12/2020	12/2020
Last Calibration Date	Last Calibration Date

Date Operator's Sign Inspector's Sign

Overall results:

The achieved test results show that the instrumment is completely functional, and the measuring results lie within +/- 1% of the original calibration. [1)]

The calibration of the Fieldcheck test system is fully traceable to national standards.

1) Prerequisite is an additional proof of electrode integrity with a high voltage test.

FieldCheck - Result Tab Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W25-ULGA1AC2BABW**	Tag Name	**ME FLOWS**
Device type	**PROMAG 50 W DN25**	K-Factor	**0.7086 - 0.7086**
Serial number	**KC080316000**	Zero point	**-29**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:19 AM**

Verification Flow end value (100 %): 31.122 gal/m
Flow speed 4.00 m/s

Passed / Failed	Test item	Simul. Signal	Limit Value	Deviation
	Test Transmitter			
✓	Amplifier	1.556 gal/m (5%)	1.50 %	0.63 %
✓		7.781 gal/m (25.0%)	0.70 %	0.06 %
✓		15.561 gal/m (50.0%)	0.60 %	-0.01 %
✓		31.122 gal/m (100%)	0.55 %	0.00 %
✓	Current Output 1	4.000 mA (0%)	0.05 mA	0.001 mA
✓		4.800 mA (5%)	0.05 mA	0.000 mA
✓		8.000 mA (25.0%)	0.05 mA	-0.020 mA
✓		12.000 mA (50.0%)	0.05 mA	-0.001 mA
✓		20.000 mA (100%)	0.05 mA	0.004 mA
		Start value	**Limits range**	**Measured value**
	Test Sensor			
✓	Coil Curr. Rise	2.400 ms	0.000..8.750 ms	3.502 ms
✓	Coil Curr. Stability		---	---
✓	Electrode Integrity	mV	0.0..300.000 mV	3.291 mV

Legend of symbols

✓	✗	–	?	!
Passed	Failed	not tested	not testable	Attention

FieldCheck: Parameters Transmitter

Customer	**City of Warren**	Plant	**Warren WWTP**
Order code	**50W25-ULGA1AC2BABW**	Tag Name	**ME FLOWS**
Device type	**PROMAG 50 W DN25**	K-Factor	**0.7086 - 0.7086**
Serial number	**KC080316000**	Zero point	**-29**
Software Version Transmitter	**V2.04.00**	Software Version I/O-Module	**V1.04.10**
Verification date	**05/13/2021**	Verification time	**09:19 AM**

Curent Output	Assign	Current Range	Value 0_4mA	Value 20 mA		
Terminal 26/27	VOLUME FLOW	4-20 mA Passive	0.0 gal/m	80.00 gal/m		

Actual System Ident. 123.0

WO# 30563.01 **Type** Scheduled **Priority** **Created** 12/2/2019
Create Reason Triggered by Calendar **Created By** jlalama **Printed**

Equipment 08-07-43 INC INST PH PROBE (AIT-825) **Scheduled** 12/2/2019
Location J INCINERATOR BLDG **Delinquent** 1/1/2020
Task INST QTRLY Instrumentation Quarterly PM **Completed** 12/3/2019

Shutdown
Startup
Downtime Hours

Instructions

Quarterly PM for Instrumentation Personnel
Calibration of the pH meter (08-07-43)

located on the scrubber, on the 1st floor of the incinerator building (near the back door). The monitor is located on the 2nd floor directly above the sensor unit (on the wall).

NOTE:
Calibration of this unit can be performed in either two methods. The first can be a "Grab Sample Method" , or the second could be performed by doing the "2-Point Calibration" method.

CALIBRATION INSTRUCTIONS FOR "GRAB SAMPLE" PROCEDURE

1) Take a sample to the chemistry lab for measurement.
2) On the CM42 monitor from the measurement screen press the soft key labeled CAL.
3) Scroll using the knob to Grab Sample Cal. Then press in on the knob for OK.
4) The current measured pH and Temperature values are displayed. "Store Current Values" is highlighted. Press in on the knob for OK.
5) At this point the unit will reflect actual values, and "Grab Sample Cal Running" is displayed.
6) Once the pH value has been determined, press the "Cal" key to continue the Grab Sample Calibration.
7) Press in the knob to change the value to the Laboratory Measured Value.
8) Once all of the digits have been evaluated and/or changed, the new value will be highlighted. Use the knob to scroll to "Continue". Press in on the knob for "OK".
9) Press in on the knob for "OK" to proceed...
10) Adjustment Finished" will appear. "OK" will be highlighted. Press in on the knob for "OK" to advance.

CALIBRATION INSTRUCTIONS FOR "2-POINT" PROCEDURE

1) From the measurment screen press the left soft key labeled CAL.
2) Scroll using the knob to "2-POINT CAL". Then press in on the knob for OK.
3) The value of Buffer #1 will be displayed. Place the sensor in Buffer #1.
4) Press the knob to START CALIBRATION. Note: It may benefit to wait a short period of time before pressing the knob to start the unit reading the buffer. This is especially true with aging probes that react slower.
5) When the unit is finished reading buffer #1 it will display Buffer #2. Place the sensor in Buffer #2.
6) Press the knob to START CALIBRATION. Note: It may benefit to wait a short period of time before pressing the knob to start the unit reading the buffer. This is especially true with aging probes that react slower.
7) When the unit is finished "STORE DATA FOR ADJUSTMENT" will be highlighted. The new sensor slope will also be displayed. Press in on the knob for OK to accept the calibration.
8) Press in on the knob for "OK".
9) Press in on the knob for "OK".

NOTE:
The PLC (computer) scaling for this unit is set for:

4 ma = 0.0 pH
8 ma = 3.5 pH
12 ma = 7.0 pH
16 ma = 10.5 pH
20 ma = 14.0 pH

The meter (instrument) output scaling for this unit is:

Work Order Total

4 ma = 0.0 pH
8 ma = 3.5 pH
12 ma = 7.0 pH
16 ma = 10.5 pH
20 ma = 14.0 pH

Comments 12-03-2019 JL Today a clean small plastic collection cup was brought to the scrubber (located on the 1st floor of the incinerator building), and a "pH water grab sample" was taken from the test valve. This "grab sample pH water" was taken to the chemistry lab, for comparative testing. The chemistry lab measured the water with their own certified lab meter, and the pH value result was obtained of 7.0. At the same time, the pH value desplayed from the Endress Hauser monitor (on the 2nd floor) displayed 7.0. This close value simulation was noted, and therefore "no adjustment" to the Endress Hauser meter is required at this time.

NOTE:
The PLC (computer) scaling for this unit is set for:

4 ma = 0.0 pH
8 ma = 3.5 pH
12 ma = 7.0 pH
16 ma = 10.5 pH
20 ma = 14.0 pH

The meter (instrument) output scaling for this unit is:

4 ma = 0.0 pH
8 ma = 3.5 pH
12 ma = 7.0 pH
16 ma = 10.5 pH
20 ma = 14.0 pH

Work Order Total

Report Totals	**Downtime Hours**	0	**Part Cost**	$0.00
			Labor Cost	$0.00
			Vendor Cost	$0.00
			Tool/Equip Cost	$0.00
			Total Cost	$0.00

WO# 30417.01 **Type** Scheduled **Priority**

Create Reason Triggered by Calendar **Created By** jlalama

Equipment 07-10-25 SOL INST CAKE SCALE

Location I SOLIDS BLDG

Task INST ANNU Instrumentation Annual PM

Created 8/1/2019
Printed
Scheduled 7/1/2019
Delinquent 7/31/2019
Completed 8/13/2019

Shutdown
Startup
Downtime Hours

Instructions

Annual PM for Instrumentation Personnel
Calibration of Cake Scale meter (07-10-25)

located in the solids building, on the incline ramp.

NOTE:

To perform a "Zero Cal"

1) Press menu
2) Select "Zero Cal" (soft key) Button
3) Press "Start" button (takes about 3 minutes to complete)
4) When complete press "Yes"
5) Return back to the menu screen.

To perform a "Span Cal" (with the chain)

1) Press menu
2) Select "Span Cal" (soft key) button
3) Press "start" (soft key) button
4) (Install chain on belt)
5) Press "start" (soft key) button
6) Press "start" (soft key) button
7) (This cal takes about 5 minutes)
8) Return back to the menu screen.

Note:

The Instrument (Tonage) scaling is:

Tonage	mA
0 Ton/Hr.	= 4 mA
5 Ton/Hr.	= 8 mA
10 Ton/Hr.	= 12 mA
15 Ton/Hr.	= 16 mA
20 Ton/Hr.	= 20 mA

The PLC (computer) scaling is:

Tonage	mA
0 Ton/Hr.	= 4 mA
5 Ton/Hr.	= 8 mA
10 Ton/Hr.	= 12 mA
15 Ton/Hr.	= 16 mA
20 Ton/Hr.	= 20 mA

Comments 08-13-2019 JL Today Brian Hutchison (from Boni Hutchison Company @ 734-536-2516) came put and calibrated the Thermo Scientific Belt Scale Meter, that's located in the solids building. Once completed, he issued a certificate and data sheet (which will be kept on file in the calibration office) just in case the State of Michigan performs an audit at our facility.

Work Order Total

Report Totals	Downtime Hours	0	Part Cost	$0.00
			Labor Cost	$0.00
			Vendor Cost	$0.00
			Tool/Equip Cost	$0.00
			Total Cost	$0.00

Equip #07-10-25

CERTIFICATE of CALIBRATION

THIS CERTIFIES THAT

THERMO SCIENTIFIC, M/N 9101,

S/N 13410147, BELT SCALE METER

CITY OF WARREN

WASTE WATER TREATMENT PLANT

WARREN, MICHIGAN 48093

HAS SUCCESSFULLY COMPLETED THE CALIBRATION AND TESTING PROGRAM CONDUCTED BY

8-13-2019
DATE

Brian Boni
Brian Boni

Aug 2019 THRU Aug 2020

APPENDIX E

Operating Parameter Limitations
Based on Recent Compliance Testing

Warren Wastewater Treatment Plant Incinerator Testing
Operating Data And Calculated Operating Limits

	Incinerator Hearth Temperatures (1-Min Raw Data) in °F							
Date/Time	Hearth 1	Hearth 2	Hearth 3	Hearth 4	Hearth 5	Hearth 6	Hearth 7	Hearth 8
6/17/2020 15:56	952	1051	1001	1328	1243	1569	1389	853
6/17/2020 15:57	952	1049	1001	1312	1216	1557	1387	853
6/17/2020 15:58	950	1047	1001	1307	1207	1566	1400	855
6/17/2020 15:59	949	1044	1001	1307	1198	1555	1398	855
6/17/2020 16:00	950	1044	1001	1318	1218	1564	1392	853
6/17/2020 16:01	949	1042	1001	1310	1204	1554	1391	854
6/17/2020 16:02	947	1038	1001	1309	1208	1563	1404	856
6/17/2020 16:03	946	1038	1001	1310	1205	1556	1400	855
6/17/2020 16:04	947	1041	1001	1319	1222	1564	1395	853
6/17/2020 16:05	946	1039	1001	1302	1199	1552	1394	854
6/17/2020 16:06	944	1041	1001	1294	1191	1556	1403	856
6/17/2020 16:07	943	1042	1001	1294	1185	1549	1397	855
6/17/2020 16:08	943	1043	1001	1296	1195	1554	1389	853
6/17/2020 16:09	944	1043	1001	1284	1174	1546	1390	855
6/17/2020 16:10	942	1040	1000	1280	1170	1547	1400	856
6/17/2020 16:11	942	1039	1000	1287	1175	1544	1393	855
6/17/2020 16:12	942	1037	1000	1298	1197	1546	1385	852
6/17/2020 16:13	943	1035	1000	1285	1176	1539	1386	853
6/17/2020 16:14	942	1030	999	1279	1165	1537	1394	853
6/17/2020 16:15	947	1027	999	1285	1167	1538	1389	852
6/17/2020 16:16	952	1028	999	1292	1183	1539	1383	850

1-Hour Averages (°F)		
Hearth 4	Hearth 5	Hearth 6
1327.6	1212.7	1570.1
1327.3	1213.1	1569.7
1327.3	1213.8	1569.5
1327.2	1214.2	1569.0
1327.1	1214.9	1568.7
1326.8	1215.1	1568.2
1326.5	1215.3	1568.1
1326.1	1215.1	1567.7
1325.7	1215.1	1567.5
1325.0	1214.5	1567.2
1324.3	1214.1	1566.9
1323.6	1213.6	1566.5
1322.8	1213.1	1566.1
1321.7	1212.0	1565.7
1320.8	1211.2	1565.3
1320.1	1210.6	1564.9
1319.5	1210.5	1564.4
1318.7	1210.0	1563.9
1318.0	1209.6	1563.3
1317.3	1209.2	1562.8
1316.6	1208.9	1562.1

Combustion Chamber Temps
Hearths 4-6 (4-Hr Average °F)
1367.9
1368.1
1368.2
1368.3
1368.5
1368.7
1368.9
1368.8
1368.8
1368.7
1368.5
1368.4
1368.3
1368.1
1367.8
1367.6
1367.5
1367.3
1367.0
1366.8
1366.6

New Subpart MMMM Operating Limit

Minimum 4-Hour Average Temp (°F): 1346.0

Warren Wastewater Treatment Plant Incinerator Testing
Operating Data And Calculated Operating Limits

Date/Time	Wet Sludge Feed Rate 1-min Data (ton/hr)	Wet Sludge Feed 1 Hour Average (ton/hr)	Scrubber dP 1-min Data (inch WC)	Scrubber dP 4-hour Averages (inch WC)	Scrubber Flow Rate 1-min Data (gal/min)	Scrubber Flow Rate 4-hour Averages (gal/min)	Scrubber pH 1-min Data	Scrubber pH 1-hour Averages
6/17/2020 16:06	5.30	5.54	24.0	24.7	872	851.6	6.40	
6/17/2020 16:07	5.30	5.53	24.0	24.7	872	851.7	6.40	
6/17/2020 16:08	5.37	5.53	24.0	24.7	872	851.9	6.40	
6/17/2020 16:09	5.32	5.52	24.0	24.7	886	852.2	6.40	
6/17/2020 16:10	5.29	5.52	24.1	24.7	891	852.4	6.50	
6/17/2020 16:11	5.35	5.51	24.0	24.7	876	852.6	6.50	
6/17/2020 16:12	5.40	5.51	24.0	24.7	878	852.8	6.40	
6/17/2020 16:13	5.35	5.51	24.0	24.7	871	853.0	6.40	
6/17/2020 16:14	5.30	5.51	24.0	24.6	863	853.1	6.40	
6/17/2020 16:15	5.33	5.50	24.1	24.6	864	853.2	6.40	
6/17/2020 16:16	5.38	5.50	24.1	24.6	864	853.4	6.40	

Highest 1-hr Average (ton/hr) 5.57

(85% max)

Daily Feed Rate (ton/day) 157.3

(Highest 1-Hour ave / 0.85) x 24 = ton/day

New Subpart MMMM Operating Limits

	New Limit	New Limit	New Limit
Lowest 1-Hr Averages	24.29	806.0	6.26
	inch WC	gallon/min	pH
			(HCl/SO2 testing only)

APPENDIX F

For Reference:
NSPS Subpart MMMM – eCFR March 16, 2020

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of March 16, 2020

Title 40 → Chapter I → Subchapter C → Part 60 → Subpart MMMM

Title 40: Protection of Environment
PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES (CONTINUED)

Subpart MMMM—Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units

Contents

SOURCE: 76 FR 15404, Mar. 21, 2011, unless otherwise noted.

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INTRODUCTION

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§60.5000 What is the purpose of this subpart?

This subpart establishes emission guidelines and compliance schedules for the control of emissions from sewage sludge incineration (SSI) units. The pollutants addressed by these emission guidelines are listed in Tables 2 and 3 to this subpart. These emission guidelines are developed in accordance with sections 111(d) and 129 of the Clean Air Act and subpart B of this part. To the extent any requirement of this subpart is inconsistent with the requirements of subpart A of this part, the requirements of this subpart will apply.

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§60.5005 Am I affected by this subpart?

(a) If you are the Administrator of an air quality program in a state or United States protectorate with one or more SSI units that commenced construction on or before October 14, 2010, you must submit a state plan to U.S. Environmental Protection Agency (EPA) that implements the emission guidelines contained in this subpart.

(b) You must submit the state plan to EPA by March 21, 2012.

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§60.5010 Is a state plan required for all states?

No. You are not required to submit a state plan if there are no SSI units for which construction commenced on or before October 14, 2010 in your state, and you submit a negative declaration letter in place of the state plan.

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§60.5015 What must I include in my state plan?

(a) You must include the nine items described in paragraphs (a)(1) through (a)(9) of this section in your state plan.

(1) Inventory of affected SSI units, including those that have ceased operation but have not been dismantled.

(2) Inventory of emissions from affected SSI units in your state.

(3) Compliance schedules for each affected SSI unit.

(4) Emission limits, emission standards, operator training and qualification requirements, and operating limits for affected SSI units that are at least as protective as the emission guidelines contained in this subpart.

(5) Performance testing, recordkeeping, and reporting requirements.

(6) Certification that the hearing on the state plan was held, a list of witnesses and their organizational affiliations, if any, appearing at the hearing, and a brief written summary of each presentation or written submission.

(7) Provision for state progress reports to EPA.

(8) Identification of enforceable state mechanisms that you selected for implementing the emission guidelines of this subpart.

(9) Demonstration of your state's legal authority to carry out the sections 111(d) and 129 state plan.

(b) Your state plan may deviate from the format and content of the emission guidelines contained in this subpart. However, if your state plan does deviate in content, you must demonstrate that your state plan is at least as protective as the emission guidelines contained in this subpart. Your state plan must address regulatory applicability, increments of progress for retrofit, operator training and qualification, emission limits and standards, performance testing, operating limits, monitoring, and recordkeeping and reporting.

(c) You must follow the requirements of subpart B of this part (Adoption and Submittal of state plans for Designated Facilities) in your state plan.

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§60.5020 Is there an approval process for my state plan?

Yes. The EPA will review your state plan according to §60.27.

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§60.5025 What if my state plan is not approvable?

If you do not submit an approvable state plan (or a negative declaration letter) by March 21, 2013, EPA will develop a Federal plan according to §60.27 to implement the emission guidelines contained in this subpart. Owners and operators of SSI units not covered by an approved state plan must comply with the Federal plan. The Federal plan is an interim action and will be automatically withdrawn when your state plan is approved.

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§60.5030 Is there an approval process for a negative declaration letter?

No. The EPA has no formal review process for negative declaration letters. Once your negative declaration letter has been received, EPA will place a copy in the public docket and publish a notice in the FEDERAL REGISTER. If, at a later date, a SSI unit for which construction commenced on or before October 14, 2010 is found in your state, the Federal plan implementing the emission guidelines contained in this subpart would automatically apply to that SSI unit until your state plan is approved.

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§60.5035 What compliance schedule must I include in my state plan?

(a) For SSI units that commenced construction on or before October 14, 2010, your state plan must include compliance schedules that require SSI units to achieve final compliance as expeditiously as practicable after approval of the state plan but not later than the earlier of the two dates specified in paragraphs (a)(1) and (a)(2) of this section.

(1) March 21, 2016.

(2) Three years after the effective date of state plan approval.

(b) For compliance schedules that extend more than 1 year following the effective date of state plan approval, state plans must include dates for enforceable increments of progress as specified in §60.5090.

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§60.5040 Are there any state plan requirements for this subpart that apply instead of the requirements specified in subpart B?

Yes. Subpart B establishes general requirements for developing and processing section 111(d) state plans. This subpart applies instead of the requirements in subpart B of this part, as specified in paragraphs (a) and (b) of this section:

(a) State plans developed to implement this subpart must be as protective as the emission guidelines contained in this subpart. State plans must require all SSI units to comply by the dates specified in §60.5035. This applies instead of the option for case-by-case less stringent emission standards and longer compliance schedules in §60.24(f).

(b) State plans developed to implement this subpart are required to include two increments of progress for the affected SSI units. These two minimum increments are the final control plan submittal date and final compliance date in §60.21(h)(1) and (5). This applies instead of the requirement of §60.24(e)(1) that would require a state plan to include all five increments of progress for all SSI units.

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§60.5045 In lieu of a state plan submittal, are there other acceptable option(s) for a state to meet its section 111(d)/129 (b)(2) obligations?

Yes, a state may meet its Clean Air Act section 111(d)/129 obligations by submitting an acceptable written request for delegation of the Federal plan that meets the requirements of this section. This is the only other option for a state to meet its section 111(d)/129 obligations.

(a) An acceptable Federal plan delegation request must include the following:

(1) A demonstration of adequate resources and legal authority to administer and enforce the Federal plan.

(2) The items under §60.5015(a)(1), (a)(2), and (a)(7).

(3) Certification that the hearing on the state delegation request, similar to the hearing for a state plan submittal, was held, a list of witnesses and their organizational affiliations, if any, appearing at the hearing, and a brief written summary of each presentation or written submission.

(4) A commitment to enter into a Memorandum of Agreement with the Regional Administrator that sets forth the terms, conditions, and effective date of the delegation and that serves as the mechanism for the transfer of authority. Additional guidance and information is given in EPA's Delegation Manual, Item 7-139, Implementation and Enforcement of 111(d)(2) and 111(d)/(2)/129 (b)(3) Federal plans.

(b) A state with an already approved SSI Clean Air Act section 111(d)/129 state plan is not precluded from receiving EPA approval of a delegation request for the revised Federal plan, provided the requirements of paragraph (a) of this section are met, and at the time of the delegation request, the state also requests withdrawal of EPA's previous state plan approval.

(c) A state's Clean Air Act section 111(d)/129 obligations are separate from its obligations under title V of the Clean Air Act.

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§60.5050 What authorities will not be delegated to state, local, or tribal agencies?

The authorities that will not be delegated to state, local, or tribal agencies are specified in paragraphs (a) through (g) of this section.

(a) Approval of alternatives to the emission limits and standards in Tables 2 and 3 to this subpart and operating limits established under §60.5175 or §60.5190.

(b) Approval of major alternatives to test methods.

(c) Approval of major alternatives to monitoring.

(d) Approval of major alternatives to recordkeeping and reporting.

(e) The requirements in §60.5175.

(f) The requirements in §60.5155(b)(2).

(g) Performance test and data reduction waivers under §60.8(b).

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§60.5055 Does this subpart directly affect SSI unit owners and operators in my state?

(a) No. This subpart does not directly affect SSI unit owners and operators in your state. However, SSI unit owners and operators must comply with the state plan you develop to implement the emission guidelines contained in this subpart. States may choose to incorporate the model rule text directly in their state plan.

(b) If you do not submit an approvable plan to implement and enforce the guidelines contained in this subpart by March 21, 2012, EPA will implement and enforce a Federal plan, as provided in §60.5025, to ensure that each unit within your state that commenced construction on or before October 14, 2010 reaches compliance with all the provisions of this subpart by the dates specified in §60.5035.

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APPLICABILITY OF STATE PLANS

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§60.5060 What SSI units must I address in my state plan?

(a) Your state plan must address SSI units that meet all three criteria described in paragraphs (a)(1) through (3) of this section.

(1) SSI units in your state that commenced construction on or before October 14, 2010.

(2) SSI units that meet the definition of a SSI unit as defined in §60.5250.

(3) SSI units not exempt under §60.5065.

(b) If the owner or operator of a SSI unit makes changes that meet the definition of modification after September 21, 2011, the SSI unit becomes subject to subpart LLLL of this part and the state plan no longer applies to that unit.

(c) If the owner or operator of a SSI unit makes physical or operational changes to a SSI unit for which construction commenced on or before September 21, 2011 primarily to comply with your state plan, subpart LLLL of this part does not apply to that unit. Such changes do not qualify as modifications under subpart LLLL of this part.

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§60.5065 What SSI units are exempt from my state plan?

This subpart exempts combustion units that incinerate sewage sludge and are not located at a wastewater treatment facility designed to treat domestic sewage sludge. These units may be subject to another subpart of this part (*e.g.,* subpart CCCC of this part). The owner or operator of such a combustion unit must notify the Administrator of an exemption claim under this section.

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USE OF MODEL RULE

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§60.5070 What is the "model rule" in this subpart?

(a) The model rule is the portion of these emission guidelines (§§60.5085 through 60.5250) that addresses the regulatory requirements applicable to SSI units. The model rule provides these requirements in regulation format. You must develop a state plan that is at least as protective as the model rule. You may use the model rule language as part of your state plan. Alternative language may be used in your state plan if you demonstrate that the alternative language is at least as protective as the model rule contained in this subpart.

(b) In the model rule of §§60.5085 through 60.5250, "you" and "Administrator" have the meaning specified in §60.5250.

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§60.5075 How does the model rule relate to the required elements of my state plan?

Use the model rule to satisfy the state plan requirements specified in §60.5015(a)(3) through (a)(5).

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§60.5080 What are the principal components of the model rule?

The model rule contains the nine major components listed in paragraphs (a) through (i) of this section.

(a) Increments of progress toward compliance.

(b) Operator training and qualification.

(c) Emission limits, emission standards, and operating limits.

(d) Initial compliance requirements.

(e) Continuous compliance requirements.

(f) Performance testing, monitoring, and calibration requirements.

(g) Recordkeeping and reporting.

(h) Definitions.

(i) Tables.

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MODEL RULE—INCREMENTS OF PROGRESS

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§60.5085 What are my requirements for meeting increments of progress and achieving final compliance?

If you plan to achieve compliance more than 1 year following the effective date of state plan approval, you must meet the two increments of progress specified in paragraphs (a) and (b) of this section.

(a) Submit a final control plan.

(b) Achieve final compliance.

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§60.5090 When must I complete each increment of progress?

Table 1 to this subpart specifies compliance dates for each increment of progress.

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§60.5095 What must I include in the notifications of achievement of increments of progress?

Your notification of achievement of increments of progress must include the three items specified in paragraphs (a) through (c) of this section.

(a) Notification that the increment of progress has been achieved.

(b) Any items required to be submitted with each increment of progress.

(c) Signature of the owner or operator of the SSI unit.

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§60.5100 When must I submit the notifications of achievement of increments of progress?

Notifications for achieving increments of progress must be postmarked no later than 10 business days after the compliance date for the increment.

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§60.5105 What if I do not meet an increment of progress?

If you fail to meet an increment of progress, you must submit a notification to the Administrator postmarked within 10 business days after the date for that increment of progress in Table 1 to this subpart. You must inform the Administrator that you did not meet the increment, and you must continue to submit reports each subsequent calendar month until the increment of progress is met.

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§60.5110 How do I comply with the increment of progress for submittal of a control plan?

For your control plan increment of progress, you must satisfy the two requirements specified in paragraphs (a) and (b) of this section.

(a) Submit the final control plan that includes the four items described in paragraphs (a)(1) through (a)(4) of this section.

(1) A description of the devices for air pollution control and process changes that you will use to comply with the emission limits and standards and other requirements of this subpart.

(2) The type(s) of waste to be burned, if waste other than sewage sludge is burned in the unit.

(3) The maximum design sewage sludge burning capacity.

(4) If applicable, the petition for site-specific operating limits under §60.5175.

(b) Maintain an onsite copy of the final control plan.

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§60.5115 How do I comply with the increment of progress for achieving final compliance?

For the final compliance increment of progress, you must complete all process changes and retrofit construction of control devices, as specified in the final control plan, so that, if the affected SSI unit is brought online, all necessary process changes and air pollution control devices would operate as designed.

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§60.5120 What must I do if I close my SSI unit and then restart it?

(a) If you close your SSI unit but will restart it prior to the final compliance date in your state plan, you must meet the increments of progress specified in §60.5085.

(b) If you close your SSI unit but will restart it after your final compliance date, you must complete emission control retrofits and meet the emission limits, emission standards, and operating limits on the date your unit restarts operation.

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§60.5125 What must I do if I plan to permanently close my SSI unit and not restart it?

If you plan to close your SSI unit rather than comply with the state plan, submit a closure notification, including the date of closure, to the Administrator by the date your final control plan is due.

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MODEL RULE—OPERATOR TRAINING AND QUALIFICATION

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§60.5130 What are the operator training and qualification requirements?

(a) A SSI unit cannot be operated unless a fully trained and qualified SSI unit operator is accessible, either at the facility or can be at the facility within 1 hour. The trained and qualified SSI unit operator may operate the SSI unit directly or be the direct supervisor of one or more other plant personnel who operate the unit. If all qualified SSI unit operators are temporarily not accessible, you must follow the procedures in §60.5155.

(b) Operator training and qualification must be obtained through a state-approved program or by completing the requirements included in paragraph (c) of this section.

(c) Training must be obtained by completing an incinerator operator training course that includes, at a minimum, the three elements described in paragraphs (c)(1) through (c)(3) of this section.

(1) Training on the 10 subjects listed in paragraphs (c)(1)(i) through (c)(1)(x) of this section.

(i) Environmental concerns, including types of emissions.

(ii) Basic combustion principles, including products of combustion.

(iii) Operation of the specific type of incinerator to be used by the operator, including proper startup, sewage sludge feeding, and shutdown procedures.

(iv) Combustion controls and monitoring.

(v) Operation of air pollution control equipment and factors affecting performance (if applicable).

(vi) Inspection and maintenance of the incinerator and air pollution control devices.

(vii) Actions to prevent malfunctions or to prevent conditions that may lead to malfunctions.

(viii) Bottom and fly ash characteristics and handling procedures.

(ix) Applicable Federal, State, and local regulations, including Occupational Safety and Health Administration workplace standards.

(x) Pollution prevention.

(2) An examination designed and administered by the state-approved program.

(3) Written material covering the training course topics that may serve as reference material following completion of the course.

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§60.5135 When must the operator training course be completed?

The operator training course must be completed by the later of the three dates specified in paragraphs (a) through (c) of this section.

(a) The final compliance date (Increment 2).

(b) Six months after your SSI unit startup.

(c) Six months after an employee assumes responsibility for operating the SSI unit or assumes responsibility for supervising the operation of the SSI unit.

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§60.5140 How do I obtain my operator qualification?

(a) You must obtain operator qualification by completing a training course that satisfies the criteria under §60.5130(b).

(b) Qualification is valid from the date on which the training course is completed and the operator successfully passes the examination required under §60.5130(c)(2).

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§60.5145 How do I maintain my operator qualification?

To maintain qualification, you must complete an annual review or refresher course covering, at a minimum, the five topics described in paragraphs (a) through (e) of this section.

(a) Update of regulations.

(b) Incinerator operation, including startup and shutdown procedures, sewage sludge feeding, and ash handling.

(c) Inspection and maintenance.

(d) Prevention of malfunctions or conditions that may lead to malfunction.

(e) Discussion of operating problems encountered by attendees.

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§60.5150 How do I renew my lapsed operator qualification?

You must renew a lapsed operator qualification before you begin operation of a SSI unit by one of the two methods specified in paragraphs (a) and (b) of this section.

(a) For a lapse of less than 3 years, you must complete a standard annual refresher course described in §60.5145.

(b) For a lapse of 3 years or more, you must repeat the initial qualification requirements in §60.5140(a).

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§60.5155 What if all the qualified operators are temporarily not accessible?

If a qualified operator is not at the facility and cannot be at the facility within 1 hour, you must meet the criteria specified in either paragraph (a) or (b) of this section, depending on the length of time that a qualified operator is not accessible.

(a) When a qualified operator is not accessible for more than 8 hours, the SSI unit may be operated for less than 2 weeks by other plant personnel who are familiar with the operation of the SSI unit and who have completed a review of the information specified in §60.5160 within the past 12 months. However, you must record the period when a qualified operator was not accessible and include this deviation in the annual report as specified under §60.5235(d).

(b) When a qualified operator is not accessible for 2 weeks or more, you must take the two actions that are described in paragraphs (b)(1) and (b)(2) of this section.

(1) Notify the Administrator of this deviation in writing within 10 days. In the notice, state what caused this deviation, what you are doing to ensure that a qualified operator is accessible, and when you anticipate that a qualified operator will be accessible.

(2) Submit a status report to the Administrator every 4 weeks outlining what you are doing to ensure that a qualified operator is accessible, stating when you anticipate that a qualified operator will be accessible, and requesting approval from the Administrator to continue operation of the SSI unit. You must submit the first status report 4 weeks after you notify the Administrator of the deviation under paragraph (b)(1) of this section.

(i) If the Administrator notifies you that your request to continue operation of the SSI unit is disapproved, the SSI unit may continue operation for 30 days, and then must cease operation.

(ii) Operation of the unit may resume if a qualified operator is accessible as required under §60.5130(a). You must notify the Administrator within 5 days of having resumed operations and of having a qualified operator accessible.

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§60.5160 What site-specific documentation is required and how often must it be reviewed by qualified operators and plant personnel?

(a) You must maintain at the facility the documentation of the operator training procedures specified under §60.5230(c)(1) and make the documentation readily accessible to all SSI unit operators.

(b) You must establish a program for reviewing the information listed in §60.5230(c)(1) with each qualified incinerator operator and other plant personnel who may operate the unit according to the provisions of §60.5155(a), according to the following schedule:

(1) The initial review of the information listed in §60.5230(c)(1) must be conducted within 6 months after the effective date of this subpart or prior to an employee's assumption of responsibilities for operation of the SSI unit, whichever date is later.

(2) Subsequent annual reviews of the information listed in §60.5230(c)(1) must be conducted no later than 12 months following the previous review.

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MODEL RULE—EMISSION LIMITS, EMISSION STANDARDS, AND OPERATING LIMITS AND REQUIREMENTS

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§60.5165 What emission limits and standards must I meet and by when?

You must meet the emission limits and standards specified in Table 2 or 3 to this subpart by the final compliance date under the approved state plan, Federal plan, or delegation, as applicable. The emission limits and standards apply at all times the unit is operating and during periods of malfunction. The emission limits and standards apply to emissions from a bypass stack or vent while sewage sludge is in the combustion chamber (*i.e.,* until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

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§60.5170 What operating limits and requirements must I meet and by when?

You must meet, as applicable, the operating limits and requirements specified in paragraphs (a) through (d) and (h) of this section, according to the schedule specified in paragraph (e) of this section. The operating parameters for which you will establish operating limits for a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection are listed in Table 4 to this subpart. You must comply with the operating requirements in paragraph (f) of this section and the requirements in paragraph (g) of this section for meeting any new operating limits, re-established in §60.5210. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.,* until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

(a) You must meet a site-specific operating limit for minimum operating temperature of the combustion chamber (or afterburner combustion chamber) that you establish in §60.5190.

(b) If you use a wet scrubber, electrostatic precipitator, activated carbon injection, or afterburner to comply with an emission limit, you must meet the site-specific operating limits that you establish in §60.5190 for each operating parameter associated with each air pollution control device.

(c) If you use a fabric filter to comply with the emission limits, you must install the bag leak detection system specified in §§60.5200(b) and 60.5225(b)(3)(i) and operate the bag leak detection system such that the alarm does not sound more than 5 percent of the operating time during a 6-month period. You must calculate the alarm time as specified in §60.5210(a)(2)(i).

(d) You must meet the operating requirements in your site-specific fugitive emission monitoring plan, submitted as specified in §60.5200(d) to ensure that your ash handling system will meet the emission standard for fugitive emissions from ash handling.

(e) You must meet the operating limits and requirements specified in paragraphs (a) through (d) of this section by the final compliance date under the approved state plan, Federal plan, or delegation, as applicable.

(f) You must monitor the feed rate and moisture content of the sewage sludge fed to the sewage sludge incinerator, as specified in paragraphs (f)(1) and (f)(2) of this section.

(1) Continuously monitor the sewage sludge feed rate and calculate a daily average for all hours of operation during each 24-hour period. Keep a record of the daily average feed rate, as specified in §60.5230(f)(3)(ii).

(2) Take at least one grab sample per day of the sewage sludge fed to the sewage sludge incinerator. If you take more than one grab sample in a day, calculate the daily average for the grab samples. Keep a record of the daily average moisture content, as specified in §60.5230(f)(3)(ii).

(g) For the operating limits and requirements specified in paragraphs (a) through (d) and (h) of this section, you must meet any new operating limits and requirements, re-established according to §60.5210(d).

(h) If you use an air pollution control device other than a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection to comply with the emission limits in Table 2 or 3 to this subpart, you must meet any site-specific operating limits or requirements that you establish as required in §60.5175.

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§60.5175 How do I establish operating limits if I do not use a wet scrubber, fabric filter, electrostatic precipitator, activated carbon injection, or afterburner, or if I limit emissions in some other manner, to comply with the emission limits?

If you use an air pollution control device other than a wet scrubber, fabric filter, electrostatic precipitator, activated carbon injection, or afterburner, or limit emissions in some other manner (*e.g.,* materials balance) to comply with the emission limits in §60.5165, you must meet the requirements in paragraphs (a) and (b) of this section.

(a) Meet the applicable operating limits and requirements in §60.4850, and establish applicable operating limits according to §60.5190.

(b) Petition the Administrator for specific operating parameters, operating limits, and averaging periods to be established during the initial performance test and to be monitored continuously thereafter.

(1) You are responsible for submitting any supporting information in a timely manner to enable the Administrator to consider the application prior to the performance test. You must not conduct the initial performance test until after the petition has been approved by the Administrator, and you must comply with the operating limits as written, pending approval by the Administrator. Neither submittal of an application, nor the Administrator's failure to approve or disapprove the application relieves you of the responsibility to comply with any provision of this subpart.

(2) Your petition must include the five items listed in paragraphs (b)(2)(i) through (b)(2)(v) of this section.

(i) Identification of the specific parameters you propose to monitor.

(ii) A discussion of the relationship between these parameters and emissions of regulated pollutants, identifying how emissions of regulated pollutants change with changes in these parameters, and how limits on these parameters will serve to limit emissions of regulated pollutants.

(iii) A discussion of how you will establish the upper and/or lower values for these parameters that will establish the operating limits on these parameters, including a discussion of the averaging periods associated with those parameters for determining compliance.

(iv) A discussion identifying the methods you will use to measure and the instruments you will use to monitor these parameters, as well as the relative accuracy and precision of these methods and instruments.

(v) A discussion identifying the frequency and methods for recalibrating the instruments you will use for monitoring these parameters.

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§60.5180 Do the emission limits, emission standards, and operating limits apply during periods of startup, shutdown, and malfunction?

The emission limits and standards apply at all times and during periods of malfunction. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.,* until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time). For determining compliance with the CO concentration limit using CO CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured CO concentration without correcting for oxygen concentration in averaging with other CO concentrations (corrected to 7 percent O_2) to determine the 24-hour average value.

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§60.5181 How do I establish an affirmative defense for exceedance of an emission limit or standard during malfunction?

In response to an action to enforce the numerical emission standards set forth in paragraph §60.5165, you may assert an affirmative defense to a claim for civil penalties for exceedances of emission limits that are caused by malfunction, as defined in §60.2. Appropriate penalties may be assessed however, if you fail to meet your burden of proving all of the requirements in the affirmative defense. The affirmative defense shall not be available for claims for injunctive relief.

(a) To establish the affirmative defense in any action to enforce such a limit, you must timely meet the notification requirements in paragraph (b) of this section, and must prove by a preponderance of evidence that the conditions in paragraphs (a)(1) through (a)(9) of this section are met.

(1) The excess emissions:

(i) Were caused by a sudden, infrequent, and unavoidable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner, and (ii) Could not have been prevented through careful

planning, proper design or better operation and maintenance practices, and (iii) Did not stem from any activity or event that could have been foreseen and avoided, or planned for, and

(iv) Were not part of a recurring pattern indicative of inadequate design, operation, or maintenance, and

(2) Repairs were made as expeditiously as possible when the applicable emission limits were being exceeded. Off-shift and overtime labor were used, to the extent practicable to make these repairs, and (3) The frequency, amount and duration of the excess emissions (including any bypass) were minimized to the maximum extent practicable during periods of such emissions, and (4) If the excess emissions resulted from a bypass of control equipment or a process, then the bypass was unavoidable to prevent loss of life, personal injury, or severe property damage, and

(5) All possible steps were taken to minimize the impact of the excess emissions on ambient air quality, the environment and human health, and

(6) All emissions monitoring and control systems were kept in operation if at all possible consistent with safety and good air pollution control practices, and

(7) All of the actions in response to the excess emissions were documented by properly signed, contemporaneous operating logs, and

(8) At all times, the affected facility was operated in a manner consistent with good practices for minimizing emissions, and

(9) A written root cause analysis has been prepared the purpose of which is to determine, correct, and eliminate the primary causes of the malfunction and the excess emissions resulting from the malfunction event at issue. The analysis shall also specify, using best monitoring methods and engineering judgment, the amount of excess emissions that were the result of the malfunction.

(b) The owner or operator of the SSI unit experiencing an exceedance of its emission limit(s) during a malfunction, shall notify the Administrator by telephone or facsimile (fax) transmission as soon as possible, but no later than 2 business days after the initial occurrence of the malfunction, if it wishes to avail itself of an affirmative defense to civil penalties for that malfunction. The owner or operator seeking to assert an affirmative defense shall also submit a written report to the Administrator within 45 days of the initial occurrence of the exceedance of the standard in §60.5165 to demonstrate, with all necessary supporting documentation, that it has met the requirements set forth in paragraph (a) of this section. The owner or operator may seek an extension of this deadline for up to 30 additional days by submitting a written request to the Administrator before the expiration of the 45 day period. Until a request for an extension has been approved by the Administrator, the owner or operator is subject to the requirement to submit such report within 45 days of the initial occurrence of the exceedance.

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MODEL RULE—INITIAL COMPLIANCE REQUIREMENTS

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§60.5185 How and when do I demonstrate initial compliance with the emission limits and standards?

To demonstrate initial compliance with the emission limits and standards in Table 2 or 3 to this subpart, use the procedures specified in paragraph (a) of this section. In lieu of using the procedures specified in paragraph (a) of this section, you have the option to demonstrate initial compliance using the procedures specified in paragraph (b) of this section for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling. You must meet the requirements of paragraphs (a) and (b) of this section, as applicable, and paragraphs (c) through (e) of this section, according to the performance testing, monitoring, and calibration requirements in §60.5220(a) and (b).

(a) Demonstrate initial compliance using the performance test required in §60.8. You must demonstrate that your SSI unit meets the emission limits and standards specified in Table 2 or 3 to this subpart for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling using the performance test. The initial performance test must be conducted using the test methods, averaging methods, and minimum sampling volumes or durations specified in Table 2 or 3 to this subpart and according to the testing, monitoring, and calibration requirements specified in §60.5220(a).

(1) Except as provided in paragraph (e) of this section, you must demonstrate that your SSI unit meets the emission limits and standards specified in Table 2 or 3 to this subpart by your final compliance date (see Table 1 to this subpart).

(2) You may use the results from a performance test conducted within the 2 previous years that was conducted under the same conditions and demonstrated compliance with the emission limits and standards in Table 2 or 3 to this subpart, provided no process changes have been made since you conducted that performance test. However, you must continue to meet the operating limits established during the most recent performance test that demonstrated compliance with the emission limits and

standards in Table 2 or 3 to this subpart. The performance test must have used the test methods specified in Table 2 or 3 to this subpart.

(b) Demonstrate initial compliance using a continuous emissions monitoring system or continuous automated sampling system. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the FEDERAL REGISTER. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the FEDERAL REGISTER. Collect data as specified in §60.5220(b)(6) and use the following procedures:

(1) To demonstrate initial compliance with the emission limits specified in Table 2 or 3 to this subpart for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead, you may substitute the use of a continuous monitoring system in lieu of conducting the initial performance test required in paragraph (a) of this section, as follows:

(i) You may substitute the use of a continuous emissions monitoring system for any pollutant specified in paragraph (b)(1) of this section in lieu of conducting the initial performance test for that pollutant in paragraph (a) of this section. For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.

(ii) You may substitute the use of a continuous automated sampling system for mercury or dioxins/furans in lieu of conducting the annual mercury or dioxin/furan performance test in paragraph (a) of this section.

(2) If you use a continuous emissions monitoring system to demonstrate compliance with an applicable emission limit in Table 2 or 3 to this subpart, as described in paragraph (b)(1) of this section, you must use the continuous emissions monitoring system and follow the requirements specified in §60.5220(b). You must measure emissions according to §60.13 to calculate 1-hour arithmetic averages, corrected to 7 percent oxygen (or carbon dioxide). You must demonstrate initial compliance using a 24-hour block average of these 1-hour arithmetic average emission concentrations, calculated using Equation 19-19 in section 12.4.1 of Method 19 of 40 CFR part 60, appendix A-7.

(3) If you use a continuous automated sampling system to demonstrate compliance with an applicable emission limit in Table 2 or 3 to this subpart, as described in paragraph (b)(1) of this section, you must:

(i) Use the continuous automated sampling system specified in §60.58b(p) and (q), and measure and calculate average emissions corrected to 7 percent oxygen (or carbon dioxide) according to §60.58b(p) and your monitoring plan.

(A) Use the procedures specified in §60.58b(p) to calculate 24-hour block averages to determine compliance with the mercury emission limit in Table 2 to this subpart.

(B) Use the procedures specified in §60.58b(p) to calculate 2-week block averages to determine compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limit in Table 2 to this subpart.

(ii) Comply with the provisions in §60.58b(q) to develop a monitoring plan. For mercury continuous automated sampling systems, you must use Performance Specification 12B of appendix B of part 75 and Procedure 5 of appendix F of this part.

(4) Except as provided in paragraph (e) of this section, you must complete your initial performance evaluations required under your monitoring plan for any continuous emissions monitoring systems and continuous automated sampling systems by your final compliance date (see Table 1 to this subpart). Your performance evaluation must be conducted using the procedures and acceptance criteria specified in §60.5200(a)(3).

(c) To demonstrate initial compliance with the dioxins/furans toxic equivalency emission limit in Table 2 or 3 to this subpart, determine dioxins/furans toxic equivalency as follows:

(1) Measure the concentration of each dioxin/furan tetra- through octachlorinated-isomer emitted using EPA Method 23 at 40 CFR part 60, appendix A-7.

(2) Multiply the concentration of each dioxin/furan (tetra- through octa-chlorinated) isomer by its corresponding toxic equivalency factor specified in Table 5 to this subpart. (3) Sum the products calculated in accordance with paragraph (c)(2) of this section to obtain the total concentration of dioxins/furans emitted in terms of toxic equivalency.

(d) Submit an initial compliance report, as specified in §60.5235(b).

(e) If you demonstrate initial compliance using the performance test specified in paragraph (a) of this section, then the provisions of this paragraph (e) apply. If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure, you must notify the Administrator in writing as specified in §60.5235(g). You must conduct the initial performance test as soon as practicable after the force majeure occurs. The Administrator will determine whether or not to

grant the extension to the initial performance test deadline, and will notify you in writing of approval or disapproval of the request for an extension as soon as practicable. Until an extension of the performance test deadline has been approved by the Administrator, you remain strictly subject to the requirements of this subpart.

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§60.5190 How do I establish my operating limits?

(a) You must establish the site-specific operating limits specified in paragraphs (b) through (h) of this section or established in §60.5175, as applicable, during your initial performance tests required in §60.5185. You must meet the requirements in §60.5210(d) to confirm these operating limits or re-establishre-establish new operating limits using operating data recorded during any performance tests or performance evaluations required in §60.5205. You must follow the data measurement and recording frequencies and data averaging times specified in Table 4 to this subpart or as established in §60.5175, and you must follow the testing, monitoring, and calibration requirements specified in §§60.5220 and 60.5225 or established in §60.5175. You are not required to establish operating limits for the operating parameters listed in Table 4 to this subpart for a control device if you use a continuous monitoring system to demonstrate compliance with the emission limits in Table 2 or 3 to this subpart for the applicable pollutants, as follows:

(1) For a scrubber designed to control emissions of hydrogen chloride or sulfur dioxide, you are not required to establish an operating limit and monitor scrubber liquid flow rate or scrubber liquid pH if you use the continuous monitoring system specified in §§60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for hydrogen chloride or sulfur dioxide.

(2) For a scrubber designed to control emissions of particulate matter, cadmium, and lead, you are not required to establish an operating limit and monitor pressure drop across the scrubber or scrubber liquid flow rate if you use the continuous monitoring system specified in §§60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for particulate matter, cadmium, and lead.

(3) For an electrostatic precipitator designed to control emissions of particulate matter, cadmium, and lead, you are not required to establish an operating limit and monitor secondary voltage of the collection plates, secondary amperage of the collection plates, or effluent water flow rate at the outlet of the electrostatic precipitator if you use the continuous monitoring system specified in §§60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for particulate matter, lead, and cadmium.

(4) For an activated carbon injection system designed to control emissions of mercury, you are not required to establish an operating limit and monitor sorbent injection rate and carrier gas flow rate (or carrier gas pressure drop) if you use the continuous monitoring system specified in §§60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for mercury.

(5) For an activated carbon injection system designed to control emissions of dioxins/furans, you are not required to establish an operating limit and monitor sorbent injection rate and carrier gas flow rate (or carrier gas pressure drop) if you use the continuous monitoring system specified in §§60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for dioxins/furans (total mass basis or toxic equivalency basis).

(b) Minimum pressure drop across each wet scrubber used to meet the particulate matter, lead, and cadmium emission limits in Table 2 or 3 to this subpart, equal to the lowest 4-hour average pressure drop across each such wet scrubber measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits.

(c) Minimum scrubber liquid flow rate (measured at the inlet to each wet scrubber), equal to the lowest 4-hour average liquid flow rate measured during the most recent performance test demonstrating compliance with all applicable emission limits. (d) Minimum scrubber liquid pH for each wet scrubber used to meet the sulfur dioxide or hydrogen chloride emission limits in Table 2 or 3 to this subpart, equal to the lowest 1-hour average scrubber liquid pH measured during the most recent performance test demonstrating compliance with the sulfur dioxide and hydrogen chloride emission limits.

(e) Minimum combustion chamber operating temperature (or minimum afterburner temperature), equal to the lowest 4-hour average combustion chamber operating temperature (or afterburner temperature) measured during the most recent performance test demonstrating compliance with all applicable emission limits.

(f) Minimum power input to the electrostatic precipitator collection plates, equal to the lowest 4-hour average secondary electric power measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits. Power input must be calculated as the product of the secondary voltage and secondary amperage to the electrostatic precipitator collection plates. Both the secondary voltage and secondary amperage must be recorded during the performance test. (g) Minimum effluent water flow rate at the outlet of the electrostatic precipitator, equal to the lowest 4-hour average effluent water flow rate at the outlet of the electrostatic precipitator measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits. (h) For activated carbon injection, establish the site-specific operating limits specified in paragraphs (h)(1) through (h)(3) of this section.

(1) Minimum mercury sorbent injection rate, equal to the lowest 4-hour average mercury sorbent injection rate measured during the most recent performance test demonstrating compliance with the mercury emission limit.

(2) Minimum dioxin/furan sorbent injection rate, equal to the lowest 4-hour average dioxin/furan sorbent injection rate measured during the most recent performance test demonstrating compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limit.

(3) Minimum carrier gas flow rate or minimum carrier gas pressure drop, as follows:

(i) Minimum carrier gas flow rate, equal to the lowest 4-hour average carrier gas flow rate measured during the most recent performance test demonstrating compliance with the applicable emission limit.

(ii) Minimum carrier gas pressure drop, equal to the lowest 4-hour average carrier gas flow rate measured during the most recent performance test demonstrating compliance with the applicable emission limit.

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§60.5195 By what date must I conduct the initial air pollution control device inspection and make any necessary repairs?

(a) You must conduct an air pollution control device inspection according to §60.5220(c) by the final compliance date under the approved state plan, Federal plan, or delegation, as applicable. For air pollution control devices installed after the final compliance date, you must conduct the air pollution control device inspection within 60 days after installation of the control device.

(b) Within 10 operating days following the air pollution control device inspection under paragraph (a) of this section, all necessary repairs must be completed unless you obtain written approval from the Administrator establishing a date whereby all necessary repairs of the SSI unit must be completed.

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§60.5200 How do I develop a site-specific monitoring plan for my continuous monitoring, bag leak detection, and ash handling systems, and by what date must I conduct an initial performance evaluation?

You must develop and submit to the Administrator for approval a site-specific monitoring plan for each continuous monitoring system required under this subpart, according to the requirements in paragraphs (a) through (c) of this section. This requirement also applies to you if you petition the Administrator for alternative monitoring parameters under §60.13(i) and paragraph (e) of this section. If you use a continuous automated sampling system to comply with the mercury or dioxin/furan (total mass basis or toxic equivalency basis) emission limits, you must develop your monitoring plan as specified in §60.58b(q), and you are not required to meet the requirements in paragraphs (a) and (b) of this section. You must also submit a site-specific monitoring plan for your ash handling system, as specified in paragraph (d) of this section. You must submit and update your monitoring plans as specified in paragraphs (f) through (h) of this section.

(a) For each continuous monitoring system, your monitoring plan must address the elements and requirements specified in paragraphs (a)(1) through (a)(8) of this section. You must operate and maintain the continuous monitoring system in continuous operation according to the site-specific monitoring plan.

(1) Installation of the continuous monitoring system sampling probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions (*e.g.,* on or downstream of the last control device).

(2) Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems.

(3) Performance evaluation procedures and acceptance criteria (*e.g.,* calibrations).

(i) For continuous emissions monitoring systems, your performance evaluation and acceptance criteria must include, but is not limited to, the following:

(A) The applicable requirements for continuous emissions monitoring systems specified in §60.13.

(B) The applicable performance specifications (*e.g.,* relative accuracy tests) in appendix B of this part.

(C) The applicable procedures (*e.g.,* quarterly accuracy determinations and daily calibration drift tests) in appendix F of this part.

(D) A discussion of how the occurrence and duration of out-of-control periods will affect the suitability of CEMS data, where out-of-control has the meaning given in section (a)(7)(i) of this section.

(ii) For continuous parameter monitoring systems, your performance evaluation and acceptance criteria must include, but is not limited to, the following:

(A) If you have an operating limit that requires the use of a flow monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(A)(*1*) through (*4*) of this section.

(*1*) Install the flow sensor and other necessary equipment in a position that provides a representative flow.

(*2*) Use a flow sensor with a measurement sensitivity of no greater than 2 percent of the expected process flow rate.

(*3*) Minimize the effects of swirling flow or abnormal velocity distributions due to upstream and downstream disturbances.

(*4*) Conduct a flow monitoring system performance evaluation in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(B) If you have an operating limit that requires the use of a pressure monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(B)(*1*) through (*6*) of this section.

(*1*) Install the pressure sensor(s) in a position that provides a representative measurement of the pressure (*e.g.,* particulate matter scrubber pressure drop).

(*2*) Minimize or eliminate pulsating pressure, vibration, and internal and external corrosion.

(*3*) Use a pressure sensor with a minimum tolerance of 1.27 centimeters of water or a minimum tolerance of 1 percent of the pressure monitoring system operating range, whichever is less.

(*4*) Perform checks at least once each process operating day to ensure pressure measurements are not obstructed (*e.g.,* check for pressure tap pluggage daily).

(*5*) Conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(*6*) If at any time the measured pressure exceeds the manufacturer's specified maximum operating pressure range, conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan and confirm that the pressure monitoring system continues to meet the performance requirements in your monitoring plan. Alternatively, install and verify the operation of a new pressure sensor.

(C) If you have an operating limit that requires a pH monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(C)(*1*) through (*4*) of this section.

(*1*) Install the pH sensor in a position that provides a representative measurement of scrubber effluent pH.

(*2*) Ensure the sample is properly mixed and representative of the fluid to be measured.

(*3*) Conduct a performance evaluation of the pH monitoring system in accordance with your monitoring plan at least once each process operating day.

(*4*) Conduct a performance evaluation (including a two-point calibration with one of the two buffer solutions having a pH within 1 of the operating limit pH level) of the pH monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than quarterly.

(D) If you have an operating limit that requires the use of a temperature measurement device, you must meet the requirements in paragraphs (a)(3)(ii)(D)(*1*) through (*4*) of this section.

(*1*) Install the temperature sensor and other necessary equipment in a position that provides a representative temperature.

(*2*) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 1.0 percent of the temperature value, whichever is larger, for a noncryogenic temperature range.

(*3*) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 2.5 percent of the temperature value, whichever is larger, for a cryogenic temperature range.

(*4*) Conduct a temperature measurement device performance evaluation at the time of each performance test but no less frequently than annually.

(E) If you have an operating limit that requires a secondary electric power monitoring system for an electrostatic precipitator, you must meet the requirements in paragraphs (a)(3)(ii)(E)(*1*) and (*2*) of this section.

(*1*) Install sensors to measure (secondary) voltage and current to the electrostatic precipitator collection plates.

(*2*) Conduct a performance evaluation of the electric power monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(F) If you have an operating limit that requires the use of a monitoring system to measure sorbent injection rate (*e.g.,* weigh belt, weigh hopper, or hopper flow measurement device), you must meet the requirements in paragraphs (a)(3)(ii)(F)(*1*) and (*2*) of this section.

(*1*) Install the system in a position(s) that provides a representative measurement of the total sorbent injection rate.

(*2*) Conduct a performance evaluation of the sorbent injection rate monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(4) Ongoing operation and maintenance procedures in accordance with the general requirements of §60.11(d).

(5) Ongoing data quality assurance procedures in accordance with the general requirements of §60.13.

(6) Ongoing recordkeeping and reporting procedures in accordance with the general requirements of §60.7(b), (c), (c)(1), (c)(4), (d), (e), (f) and (g).

(7) Provisions for periods when the continuous monitoring system is out of control, as follows:

(i) A continuous monitoring system is out of control if the conditions of paragraph (a)(7)(i)(A) or (a)(7)(i)(B) of this section are met.

(A) The zero (low-level), mid-level (if applicable), or high-level calibration drift exceeds two times the applicable calibration drift specification in the applicable performance specification or in the relevant standard.

(B) The continuous monitoring system fails a performance test audit (*e.g.,* cylinder gas audit), relative accuracy audit, relative accuracy test audit, or linearity test audit.

(ii) When the continuous monitoring system is out of control as specified in paragraph (a)(7)(i) of this section, you must take the necessary corrective action and must repeat all necessary tests that indicate that the system is out of control. You must take corrective action and conduct retesting until the performance requirements are below the applicable limits. The beginning of the out-of-control period is the hour you conduct a performance check (*e.g.,* calibration drift) that indicates an exceedance of the performance requirements established under this part. The end of the out-of-control period is the hour following the completion of corrective action and successful demonstration that the system is within the allowable limits.

(8) Schedule for conducting initial and periodic performance evaluations of your continuous monitoring systems.

(b) If a bag leak detection system is used, your monitoring plan must include a description of the following items:

(1) Installation of the bag leak detection system in accordance with paragraphs (b)(1)(i) and (ii) of this section.

(i) Install the bag leak detection sensor(s) in a position(s) that will be representative of the relative or absolute particulate matter loadings for each exhaust stack, roof vent, or compartment (*e.g.,* for a positive pressure fabric filter) of the fabric filter.

(ii) Use a bag leak detection system certified by the manufacturer to be capable of detecting particulate matter emissions at concentrations of 10 milligrams per actual cubic meter or less.

(2) Initial and periodic adjustment of the bag leak detection system, including how the alarm set-point will be established. Use a bag leak detection system equipped with a system that will sound an alarm when the system detects an increase in relative particulate matter emissions over a preset level. The alarm must be located where it is observed readily and any alert is detected and recognized easily by plant operating personnel.

(3) Evaluations of the performance of the bag leak detection system, performed in accordance with your monitoring plan and consistent with the guidance provided in Fabric Filter Bag Leak Detection Guidance, EPA-454/R-98-015, September 1997 (incorporated by reference, see §60.17).

(4) Operation of the bag leak detection system, including quality assurance procedures.

(5) Maintenance of the bag leak detection system, including a routine maintenance schedule and spare parts inventory list.

(6) Recordkeeping (including record retention) of the bag leak detection system data. Use a bag leak detection system equipped with a device to continuously record the output signal from the sensor. (c) You must conduct an initial performance evaluation of each continuous monitoring system and bag leak detection system, as applicable, in accordance with your monitoring plan and to §60.13(c). For the purpose of this subpart, the provisions of §60.13(c) also apply to the bag leak detection system. You must conduct the initial performance evaluation of each continuous monitoring system within 60 days of installation of the monitoring system

(d) You must submit a monitoring plan specifying the ash handling system operating procedures that you will follow to ensure that you meet the fugitive emissions limit specified in Table 2 or 3 to this subpart.

(e) You may submit an application to the Administrator for approval of alternate monitoring requirements to demonstrate compliance with the standards of this subpart, subject to the provisions of paragraphs (e)(1) through (e)(6) of this section.

(1) The Administrator will not approve averaging periods other than those specified in this section, unless you document, using data or information, that the longer averaging period will ensure that emissions do not exceed levels achieved over the duration of three performance test runs.

(2) If the application to use an alternate monitoring requirement is approved, you must continue to use the original monitoring requirement until approval is received to use another monitoring requirement.

(3) You must submit the application for approval of alternate monitoring requirements no later than the notification of performance test. The application must contain the information specified in paragraphs (e)(3)(i) through (e)(3)(iii) of this section:

(i) Data or information justifying the request, such as the technical or economic infeasibility, or the impracticality of using the required approach.

(ii) A description of the proposed alternative monitoring requirement, including the operating parameter to be monitored, the monitoring approach and technique, the averaging period for the limit, and how the limit is to be calculated.

(iii) Data or information documenting that the alternative monitoring requirement would provide equivalent or better assurance of compliance with the relevant emission standard.

(4) The Administrator will notify you of the approval or denial of the application within 90 calendar days after receipt of the original request, or within 60 calendar days of the receipt of any supplementary information, whichever is later. The Administrator will not approve an alternate monitoring application unless it would provide equivalent or better assurance of compliance with the relevant emission standard. Before disapproving any alternate monitoring application, the Administrator will provide the following:

(i) Notice of the information and findings upon which the intended disapproval is based.

(ii) Notice of opportunity for you to present additional supporting information before final action is taken on the application. This notice will specify how much additional time is allowed for you to provide additional supporting information.

(5) You are responsible for submitting any supporting information in a timely manner to enable the Administrator to consider the application prior to the performance test. Neither submittal of an application, nor the Administrator's failure to approve or disapprove the application relieves you of the responsibility to comply with any provision of this subpart.

(6) The Administrator may decide at any time, on a case-by-case basis, that additional or alternative operating limits, or alternative approaches to establishing operating limits, are necessary to demonstrate compliance with the emission standards of this subpart.

(f) You must submit your monitoring plans required in paragraphs (a) and (b) of this section at least 60 days before your initial performance evaluation of your continuous monitoring system(s).

(g) You must submit your monitoring plan for your ash handling system, as required in paragraph (d) of this section, at least 60 days before your initial compliance test date.

(h) You must update and resubmit your monitoring plan if there are any changes or potential changes in your monitoring procedures or if there is a process change, as defined in §60.5250.

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MODEL RULE—CONTINUOUS COMPLIANCE REQUIREMENTS

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§60.5205 How and when do I demonstrate continuous compliance with the emission limits and standards?

To demonstrate continuous compliance with the emission limits and standards specified in Table 2 or 3 to this subpart, use the procedures specified in paragraph (a) of this section. In lieu of using the procedures specified in paragraph (a) of this section, you have the option to demonstrate initial compliance using the procedures specified in paragraph (b) of this section for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling. You must meet the requirements of paragraphs (a) and (b) of this section, as applicable, and paragraphs (c) through (e) of this section, according to the performance testing, monitoring, and calibration requirements in §60.5220(a) and (b). You may also petition the Administrator for alternative monitoring parameters as specified in paragraph (f) of this section.

(a) Demonstrate continuous compliance using a performance test. Except as provided in paragraphs (a)(3) and (e) of this section, following the date that the initial performance test for each pollutant in Table 2 or 3 to this subpart is completed, you must conduct a performance test for each such pollutant on an annual basis (between 11 and 13 calendar months following the previous performance test). The performance test must be conducted using the test methods, averaging methods, and minimum sampling volumes or durations specified in Table 2 or 3 to this subpart and according to the testing, monitoring, and calibration requirements specified in §60.5220(a).

(1) You may conduct a repeat performance test at any time to establish new values for the operating limits to apply from that point forward. The Administrator may request a repeat performance test at any time.

(2) You must repeat the performance test within 60 days of a process change, as defined in §60.5250.

(3) Except as specified in paragraphs (a)(1) and (2) of this section, you can conduct performance tests less often for a given pollutant, as specified in paragraphs (a)(3)(i) through (iii) of this section.

(i) You can conduct performance tests less often if your performance tests for the pollutant for at least 2 consecutive years show that your emissions are at or below 75 percent of the emission limit specified in Table 2 or 3 to this subpart, and there are no changes in the operation of the affected source or air pollution control equipment that could increase emissions. In this case, you do not have to conduct a performance test for that pollutant for the next 2 years. You must conduct a performance test during the third year and no more than 37 months after the previous performance test.(ii) If your SSI unit continues to meet the emission limit for the pollutant, you may choose to conduct performance tests for the pollutant every third year if your emissions are at or below 75 percent of the emission limit, and if there are no changes in the operation of the affected source or air pollution control equipment that could increase emissions, but each such performance test must be conducted no more than 37 months after the previous performance test.

(iii) If a performance test shows emissions exceeded 75 percent of the emission limit for a pollutant, you must conduct annual performance tests for that pollutant until all performance tests over 2 consecutive years show compliance.

(b) Demonstrate continuous compliance using a continuous emissions monitoring system or continuous automated sampling system. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the FEDERAL REGISTER. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the FEDERAL REGISTER. Collect data as specified in §60.5220(b)(6) and use the following procedures:

(1) To demonstrate continuous compliance with the emission limits for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead, you may substitute the use of a continuous monitoring system in lieu of conducting the annual performance test required in paragraph (a) of this section, as follows:

(i) You may substitute the use of a continuous emissions monitoring system for any pollutant specified in paragraph (b)(1) of this section in lieu of conducting the annual performance test for that pollutant in paragraph (a) of this section. For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.

(ii) You may substitute the use of a continuous automated sampling system for mercury or dioxins/furans in lieu of conducting the annual mercury or dioxin/furan performance test in paragraph (a) of this section.

(2) If you use a continuous emissions monitoring system to demonstrate compliance with an applicable emission limit in paragraph (b)(1) of this section, you must use the continuous emissions monitoring system and follow the requirements specified in §60.5220(b). You must measure emissions according to §60.13 to calculate 1-hour arithmetic averages, corrected to 7 percent oxygen (or carbon dioxide). You must demonstrate initial compliance using a 24-hour block average of these 1-hour arithmetic average emission concentrations, calculated using Equation 19-19 in section 12.4.1 of Method 19 of 40 CFR part 60, appendix A-7.

(3) If you use a continuous automated sampling system to demonstrate compliance with an applicable emission limit in paragraph (b)(1) of this section, you must:

(i) Use the continuous automated sampling system specified in §60.58b(p) and (q), and measure and calculate average emissions corrected to 7 percent oxygen (or carbon dioxide) according to §60.58b(p) and your monitoring plan.

(A) Use the procedures specified in §60.58b(p) to calculate 24-hour averages to determine compliance with the mercury emission limit in Table 2 to this subpart.

(B) Use the procedures specified in §60.58b(p) to calculate 2-week averages to determine compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limits in Table 2 to this subpart.

(ii) Update your monitoring plan as specified in §60.4880(e). For mercury continuous automated sampling systems, you must use Performance Specification 12B of appendix B of part 75 and Procedure 5 of appendix F of this part.

(4) Except as provided in paragraph (e) of this section, you must complete your periodic performance evaluations required in your monitoring plan for any continuous emissions monitoring systems and continuous automated sampling systems, according to the schedule specified in your monitoring plan. If you were previously determining compliance by conducting an annual performance test (or according to the less frequent testing for a pollutant as provided in paragraph (a)(3) of this section), you must complete the initial performance evaluation required under your monitoring plan in §60.5200 for the continuous monitoring system prior to using the continuous emissions monitoring system to demonstrate compliance or continuous automated sampling system. Your performance evaluation must be conducted using the procedures and acceptance criteria specified in §60.5200(a)(3).

(c) To demonstrate compliance with the dioxins/furans toxic equivalency emission limit in paragraph (a) or (b) of this section, you must determine dioxins/furans toxic equivalency as follows:

(1) Measure the concentration of each dioxin/furan tetra- through octachlorinated-isomer emitted using Method 23 at 40 CFR part 60, appendix A-7.

(2) For each dioxin/furan (tetra- through octachlorinated) isomer measured in accordance with paragraph (c)(1) of this section, multiply the isomer concentration by its corresponding toxic equivalency factor specified in Table 5 to this subpart.

(3) Sum the products calculated in accordance with paragraph (c)(2) of this section to obtain the total concentration of dioxins/furans emitted in terms of toxic equivalency.

(d) You must submit an annual compliance report as specified in §60.5235(c). You must submit a deviation report as specified in §60.5235(d) for each instance that you did not meet each emission limit in Table 2 to this subpart.

(e) If you demonstrate continuous compliance using a performance test, as specified in paragraph (a) of this section, then the provisions of this paragraph (e) apply. If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure, you must notify the Administrator in writing as specified in §60.5235(g). You must conduct the performance test as soon as practicable after the force majeure occurs. The Administrator will determine whether or not to grant the extension to the performance test deadline, and will notify you in writing of approval or disapproval of the request for an extension as soon as practicable. Until an extension of the performance test deadline has been approved by the Administrator, you remain strictly subject to the requirements of this subpart.

(f) After any initial requests in §60.5200 for alternative monitoring requirements for initial compliance, you may subsequently petition the Administrator for alternative monitoring parameters as specified in §§60.13(i) and 60.5200(e).

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§60.5210 How do I demonstrate continuous compliance with my operating limits?

You must continuously monitor your operating parameters as specified in paragraph (a) of this section and meet the requirements of paragraphs (b) and (c) of this section, according to the monitoring and calibration requirements in §60.5225. You must confirm and re-establish your operating limits as specified in paragraph (d) of this section.

(a) You must continuously monitor the operating parameters specified in paragraphs (a)(1) and (a)(2) of this section using the continuous monitoring equipment and according to the procedures specified in §60.5225 or established in §60.5175. To determine compliance, you must use the data averaging period specified in Table 4 to this subpart (except for alarm time of the baghouse leak detection system) unless a different averaging period is established under §60.5175.

(1) You must demonstrate that the SSI unit meets the operating limits established according to §§60.5175 and 60.5190 and paragraph (d) of this section for each applicable operating parameter.

(2) You must demonstrate that the SSI unit meets the operating limit for bag leak detection systems as follows:

(i) For a bag leak detection system, you must calculate the alarm time as follows:

(A) If inspection of the fabric filter demonstrates that no corrective action is required, no alarm time is counted.

(B) If corrective action is required, each alarm time shall be counted as a minimum of 1 hour.

(C) If you take longer than 1 hour to initiate corrective action, each alarm time (*i.e.,* time that the alarm sounds) is counted as the actual amount of time taken by you to initiate corrective action.

(ii) Your maximum alarm time is equal to 5 percent of the operating time during a 6-month period, as specified in §60.5170 (c).

(b) Operation above the established maximum, below the established minimum, or outside the allowable range of the operating limits specified in paragraph (a) of this section constitutes a deviation from your operating limits established under this subpart, except during performance tests conducted to determine compliance with the emission and operating limits or to establish new operating limits. You must submit the deviation report specified in §60.5235(d) for each instance that you did not meet one of your operating limits established under this subpart.

(c) You must submit the annual compliance report specified in §60.5235(c) to demonstrate continuous compliance.

(d) You must confirm your operating limits according to paragraph (d)(1) of this section or re-establish operating limits according to paragraph (d)(2) of this section. Your operating limits must be established so as to assure ongoing compliance with the emission limits. These requirements also apply to your operating requirements in your fugitive emissions monitoring plan specified in §60.5170(d).

(1) Your operating limits must be based on operating data recorded during any performance test required in §60.5205(a) or any performance evaluation required in §60.5205(b)(4).

(2) You may conduct a repeat performance test at any time to establish new values for the operating limits to apply from that point forward.

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§60.5215 By what date must I conduct annual air pollution control device inspections and make any necessary repairs?

(a) You must conduct an annual inspection of each air pollution control device used to comply with the emission limits, according to §60.5220(c), no later than 12 months following the previous annual air pollution control device inspection.

(b) Within 10 operating days following an air pollution control device inspection, all necessary repairs must be completed unless you obtain written approval from the Administrator establishing a date whereby all necessary repairs of the affected SSI unit must be completed.

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MODEL RULE—PERFORMANCE TESTING, MONITORING, AND CALIBRATION REQUIREMENTS

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§60.5220 What are the performance testing, monitoring, and calibration requirements for compliance with the emission limits and standards?

You must meet, as applicable, the performance testing requirements specified in paragraph (a) of this section, the monitoring requirements specified in paragraph (b) of this section, the air pollution control device inspections requirements specified in paragraph (c) of this section, and the bypass stack provisions specified in paragraph (d) of this section.

(a) *Performance testing requirements.* (1) All performance tests must consist of a minimum of three test runs conducted under conditions representative of normal operations, as specified in §60.8(c). Emissions in excess of the emission limits or standards during periods of startup, shutdown, and malfunction are considered deviations from the applicable emission limits or standards.

(2) You must document that the dry sludge burned during the performance test is representative of the sludge burned under normal operating conditions by:

(i) Maintaining a log of the quantity of sewage sludge burned during the performance test by continuously monitoring and recording the average hourly rate that sewage sludge is fed to the incinerator.

(ii) Maintaining a log of the moisture content of the sewage sludge burned during the performance test by taking grab samples of the sewage sludge fed to the incinerator for each 8 hour period that testing is conducted.

(3) All performance tests must be conducted using the test methods, minimum sampling volume, observation period, and averaging method specified in Table 2 or 3 to this subpart.

(4) Method 1 at 40 CFR part 60, appendix A must be used to select the sampling location and number of traverse points.

(5) Method 3A or 3B at 40 CFR part 60, appendix A-2 must be used for gas composition analysis, including measurement of oxygen concentration. Method 3A or 3B at 40 CFR part 60, appendix A-2 must be used simultaneously with each method.

(6) All pollutant concentrations must be adjusted to 7 percent oxygen using Equation 1 of this section:

$$C_{adj} = C_{meas}(20.9-7)/(20.9-\%O_2) \quad \text{(Eq. 1)}$$

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Where:

C_{adj} = Pollutant concentration adjusted to 7 percent oxygen.

C_{meas} = Pollutant concentration measured on a dry basis.

(20.9 − 7) = 20.9 percent oxygen − 7 percent oxygen (defined oxygen correction basis).

20.9 = Oxygen concentration in air, percent.

$\%O_2$ = Oxygen concentration measured on a dry basis, percent.

(7) Performance tests must be conducted and data reduced in accordance with the test methods and procedures contained in this subpart unless the Administrator does one of the following.

(i) Specifies or approves, in specific cases, the use of a method with minor changes in methodology.

(ii) Approves the use of an equivalent method.

(iii) Approves the use of an alternative method the results of which he has determined to be adequate for indicating whether a specific source is in compliance.

(iv) Waives the requirement for performance tests because you have demonstrated by other means to the Administrator's satisfaction that the affected SSI unit is in compliance with the standard.

(v) Approves shorter sampling times and smaller sample volumes when necessitated by process variables or other factors. Nothing in this paragraph is construed to abrogate the Administrator's authority to require testing under section 114 of the Clean Air Act.

(8) You must provide the Administrator at least 30 days prior notice of any performance test, except as specified under other subparts, to afford the Administrator the opportunity to have an observer present. If after 30 days notice for an initially scheduled performance test, there is a delay (due to operational problems, *etc.*) in conducting the scheduled performance test, you must notify the Administrator as soon as possible of any delay in the original test date, either by providing at least 7 days prior notice of the rescheduled date of the performance test, or by arranging a rescheduled date with the Administrator by mutual agreement.

(9) You must provide, or cause to be provided, performance testing facilities as follows:

(i) Sampling ports adequate for the test methods applicable to the SSI unit, as follows:

(A) Constructing the air pollution control system such that volumetric flow rates and pollutant emission rates can be accurately determined by applicable test methods and procedures.

(B) Providing a stack or duct free of cyclonic flow during performance tests, as demonstrated by applicable test methods and procedures.

(ii) Safe sampling platform(s).

(iii) Safe access to sampling platform(s).

(iv) Utilities for sampling and testing equipment.

(10) Unless otherwise specified in this subpart, each performance test must consist of three separate runs using the applicable test method. Each run must be conducted for the time and under the conditions specified in the applicable standard. Compliance with each emission limit must be determined by calculating the arithmetic mean of the three runs. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of forced shutdown, failure of an irreplaceable portion of the sample train, extreme meteorological conditions, or other circumstances, beyond your control, compliance may, upon the Administrator's approval, be determined using the arithmetic mean of the results of the two other runs.

(11) During each test run specified in paragraph (a)(1) of this section, you must operate your sewage sludge incinerator at a minimum of 85 percent of your maximum permitted capacity.

(b) *Continuous monitor requirements.* You must meet the following requirements, as applicable, when using a continuous monitoring system to demonstrate compliance with the emission limits in Table 2 or 3 to this subpart. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the FEDERAL REGISTER. If you elect to use a continuous emissions monitoring system instead of conducting annual performance testing, you must meet the requirements of paragraphs (b)(1) through (b)(6) of this section. If you elect to use a continuous automated

sampling system instead of conducting annual performance testing, you must meet the requirements of paragraph (b)(7) of this section. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the FEDERAL REGISTER.

(1) You must notify the Administrator 1 month before starting use of the continuous emissions monitoring system.

(2) You must notify the Administrator 1 month before stopping use of the continuous emissions monitoring system, in which case you must also conduct a performance test within prior to ceasing operation of the system.

(3) You must install, operate, calibrate, and maintain an instrument for continuously measuring and recording the emissions to the atmosphere in accordance with the following:

(i) Section 60.13 of subpart A of this part.

(ii) The following performance specifications of appendix B of this part, as applicable:

(A) For particulate matter, Performance Specification 11 of appendix B of this part.

(B) For hydrogen chloride, Performance Specification 15 of appendix B of this part.

(C) For carbon monoxide, Performance Specification 4B of appendix B of this part with spans appropriate to the applicable emission limit.

(D) [Reserved]

(E) For mercury, Performance Specification 12A of appendix B of this part.

(F) For nitrogen oxides, Performance Specification 2 of appendix B of this part.

(G) For sulfur dioxide, Performance Specification 2 of appendix B of this part.

(iii) For continuous emissions monitoring systems, the quality assurance procedures (*e.g.,* quarterly accuracy determinations and daily calibration drift tests) of appendix F of this part specified in paragraphs (b)(3)(iii)(A) through (b)(3)(iii)(G) of this section. For each pollutant, the span value of the continuous emissions monitoring system is two times the applicable emission limit, expressed as a concentration.

(A) For particulate matter, Procedure 2 in appendix F of this part.

(B) For hydrogen chloride, Procedure 1 in appendix F of this part except that the Relative Accuracy Test Audit requirements of Procedure 1 shall be replaced with the validation requirements and criteria of sections 11.1.1 and 12.0 of Performance Specification 15 of appendix B of this part.

(C) For carbon monoxide, Procedure 1 in appendix F of this part.

(D) [Reserved]

(E) For mercury, Procedures 5 in appendix F of this part.

(F) For nitrogen oxides, Procedure 1 in appendix F of this part.

(G) For sulfur dioxide, Procedure 1 in appendix F of this part.

(iv) If your monitoring system has a malfunction or out-of-control period, you must complete repairs and resume operation of your monitoring system as expeditiously as possible.

(4) During each relative accuracy test run of the continuous emissions monitoring system using the performance specifications in paragraph (b)(3)(ii) of this section, emission data for each regulated pollutant and oxygen (or carbon dioxide as established in (b)(5) of this section) must be collected concurrently (or within a 30- to 60-minute period) by both the continuous emissions monitoring systems and the test methods specified in paragraph (b)(4)(i) through (b)(4)(viii) of this section. Relative accuracy testing must be at representative operating conditions while the SSI unit is charging sewage sludge.

(i) For particulate matter, Method 5 at 40 CFR part 60, appendix A-3 or Method 26A or 29 at 40 CFR part 60, appendix A-8 shall be used.

(ii) For hydrogen chloride, Method 26 or 26A at 40 CFR part 60, appendix A-8, shall be used, as specified in Tables 1 and 2 to this subpart.

(iii) For carbon monoxide, Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4, shall be used.

(iv) For dioxins/furans, Method 23 at 40 CFR part 60, appendix A-7, shall be used.

(v) For mercury, cadmium, and lead, Method 29 at 40 CFR part 60, appendix A-8, shall be used. Alternatively for mercury, either Method 30B at 40 CFR part 60, appendix A-8 or ASTM D6784-02 (Reapproved 2008) (incorporated by reference, see §60.17), may be used.

(vi) For nitrogen oxides, Method 7 or 7E at 40 CFR part 60, appendix A-4, shall be used.

(vii) For sulfur dioxide, Method 6 or 6C at 40 CFR part 60, appendix A-4, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see §60.17) must be used. For sources that have actual inlet emissions less than 100 parts per million dry volume, the relative accuracy criterion for the inlet of the sulfur dioxide continuous emissions monitoring system should be no greater than 20 percent of the mean value of the method test data in terms of the units of the emission standard, or 5 parts per million dry volume absolute value of the mean difference between the method and the continuous emissions monitoring system, whichever is greater.

(viii) For oxygen (or carbon dioxide as established in (b)(5) of this section), Method 3A or 3B at 40 CFR part 60, appendix A-2, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see §60.17), as applicable, must be used.

(5) You may request that compliance with the emission limits be determined using carbon dioxide measurements corrected to an equivalent of 7 percent oxygen. If carbon dioxide is selected for use in diluent corrections, the relationship between oxygen and carbon dioxide levels must be established during the initial performance test according to the procedures and methods specified in paragraphs (b)(5)(i) through (b)(5)(iv) of this section. This relationship may be re-established during subsequent performance tests.

(i) The fuel factor equation in Method 3B at 40 CFR part 60, appendix A-2 must be used to determine the relationship between oxygen and carbon dioxide at a sampling location. Method 3A or 3B at 50 CFR part 60, appendix A-2, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, *see* §60.17), as applicable, must be used to determine the oxygen concentration at the same location as the carbon dioxide monitor.

(ii) Samples must be taken for at least 30 minutes in each hour.

(iii) Each sample must represent a 1-hour average.

(iv) A minimum of three runs must be performed.

(6) You must operate the continuous monitoring system and collect data with the continuous monitoring system as follows:

(i) You must collect data using the continuous monitoring system at all times the affected SSI unit is operating and at the intervals specified in paragraph (b)(6)(ii) of this section, except for periods of monitoring system malfunctions that occur during periods specified in §60.5200(a)(7)(i), repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments). Any such periods that you do not collect data using the continuous monitoring system constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(ii) You must collect continuous emissions monitoring system data in accordance with §60.13(e)(2).

(iii) Any data collected during monitoring system malfunctions, repairs associated with monitoring system malfunctions, or required monitoring system quality assurance or control activities must not be included in calculations used to report emissions or operating levels. Any such periods must be reported in a deviation report.

(iv) Any data collected during periods when the monitoring system is out of control as specified in §60.4880(a)(7)(i), repairs associated with periods when the monitoring system is out of control, or required monitoring system quality assurance or control activities conducted during out-of-control periods must not be included in calculations used to report emissions or operating levels. Any such periods that do not coincide with a monitoring system malfunction as defined in §60.5250, constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(v) You must use all the data collected during all periods except those periods specified in paragraphs (b)(6)(iii) and (b)(6)(iv) of this section in assessing the operation of the control device and associated control system.

(7) If you elect to use a continuous automated sampling system instead of conducting annual performance testing, you must:

(i) Install, calibrate, maintain, and operate a continuous automated sampling system according to the site-specific monitoring plan developed in §60.58b(p)(1) through (p)(6), (p)(9), (p)(10), and (q).

(ii) Collect data according to §60.58b(p)(5) and paragraph (b)(6) of this section.

(c) *Air pollution control device inspections.* You must conduct air pollution control device inspections that include, at a minimum, the following:

(1) Inspect air pollution control device(s) for proper operation.

(2) Generally observe that the equipment is maintained in good operating condition.

(3) Develop a site-specific monitoring plan according to the requirements in §60.5200. This requirement also applies to you if you petition the EPA Administrator for alternative monitoring parameters under §60.13(i). (d) *Bypass stack.* Use of the bypass stack at any time that sewage sludge is being charged to the SSI unit is an emissions standards deviation for all pollutants listed in Table 2 or 3 to this subpart. The use of the bypass stack during a performance test invalidates the performance test.

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§60.5225 What are the monitoring and calibration requirements for compliance with my operating limits?

(a) You must install, operate, calibrate, and maintain the continuous parameter monitoring systems according to the requirements in paragraphs (a)(1) and (2) of this section.

(1) Meet the following general requirements for flow, pressure, pH, and operating temperature measurement devices:

(i) You must collect data using the continuous monitoring system at all times the affected SSI unit is operating and at the intervals specified in paragraph (a)(1)(ii) of this section, except for periods of monitoring system malfunctions that occur during periods specified defined in §60.5200(a)(7)(i), repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments). Any such periods that you do not collect data using the continuous monitoring system constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(ii) You must collect continuous parameter monitoring system data in accordance with §60.13(e)(2).

(iii) Any data collected during monitoring system malfunctions, repairs associated with monitoring system malfunctions, or required monitoring system quality assurance or control activities must not be included in calculations used to report emissions or operating levels. Any such periods must be reported in your annual deviation report.

(iv) Any data collected during periods when the monitoring system is out of control as specified in §60.5200(a)(7)(i) must not be included in calculations used to report emissions or operating levels. Any such periods that do not coincide with a monitoring system malfunction, as defined in §60.5250, constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(v) You must use all the data collected during all periods except those periods specified in paragraphs (a)(1)(iii) and (a)(1)(iv) of this section in assessing the operation of the control device and associated control system.

(vi) Record the results of each inspection, calibration, and validation check.

(2) Operate and maintain your continuous monitoring system according to your monitoring plan required under §60.4880. Additionally:

(i) For carrier gas flow rate monitors (for activated carbon injection), during the performance test conducted pursuant to §60.4885, you must demonstrate that the system is maintained within ±5 percent accuracy, according to the procedures in appendix A to part 75 of this chapter.

(ii) For carrier gas pressure drop monitors (for activated carbon injection), during the performance test conducted pursuant to §60.4885, you must demonstrate that the system is maintained within ±5 percent accuracy.

(b) You must operate and maintain your bag leak detection system in continuous operation according to your monitoring plan required under §60.4880. Additionally:

(1) For positive pressure fabric filter systems that do not duct all compartments of cells to a common stack, a bag leak detection system must be installed in each baghouse compartment or cell.

(2) Where multiple bag leak detectors are required, the system's instrumentation and alarm may be shared among detectors.

(3) You must initiate procedures to determine the cause of every alarm within 8 hours of the alarm, and you must alleviate the cause of the alarm within 24 hours of the alarm by taking whatever corrective action(s) are necessary. Corrective actions may include, but are not limited to the following:

(i) Inspecting the fabric filter for air leaks, torn or broken bags or filter media, or any other condition that may cause an increase in particulate matter emissions.

(ii) Sealing off defective bags or filter media.

(iii) Replacing defective bags or filter media or otherwise repairing the control device.

(iv) Sealing off a defective fabric filter compartment.

(v) Cleaning the bag leak detection system probe or otherwise repairing the bag leak detection system.

(vi) Shutting down the process producing the particulate matter emissions.

(c) You must operate and maintain the continuous parameter monitoring systems specified in paragraphs (a) and (b) of this section in continuous operation according to your monitoring plan required under §60.4880.

(d) If your SSI unit has a bypass stack, you must install, calibrate (to manufacturers' specifications), maintain, and operate a device or method for measuring the use of the bypass stack including date, time, and duration.

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MODEL RULE—RECORDKEEPING AND REPORTING

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§60.5230 What records must I keep?

You must maintain the items (as applicable) specified in paragraphs (a) through (n) of this section for a period of at least 5 years. All records must be available on site in either paper copy or computer-readable format that can be printed upon request, unless an alternative format is approved by the Administrator.

(a) *Date.* Calendar date of each record.

(b) *Increments of progress.* Copies of the final control plan and any additional notifications, reported under §60.5235.

(c) *Operator Training.* Documentation of the operator training procedures and records specified in paragraphs (c)(1) through (c)(4) of this section. You must make available and readily accessible at the facility at all times for all SSI unit operators the documentation specified in paragraph (c)(1) of this section.

(1) Documentation of the following operator training procedures and information:

(i) Summary of the applicable standards under this subpart.

(ii) Procedures for receiving, handling, and feeding sewage sludge.

(iii) Incinerator startup, shutdown, and malfunction preventative and corrective procedures.

(iv) Procedures for maintaining proper combustion air supply levels.

(v) Procedures for operating the incinerator and associated air pollution control systems within the standards established under this subpart.

(vi) Monitoring procedures for demonstrating compliance with the incinerator operating limits.

(vii) Reporting and recordkeeping procedures.

(viii) Procedures for handling ash.

(ix) A list of the materials burned during the performance test, if in addition to sewage sludge.

(x) For each qualified operator and other plant personnel who may operate the unit according to the provisions of §60.5155 (a), the phone and/or pager number at which they can be reached during operating hours.

(2) Records showing the names of SSI unit operators and other plant personnel who may operate the unit according to the provisions of §60.5155(a), as follows:

(i) Records showing the names of SSI unit operators and other plant personnel who have completed review of the information in paragraph (c)(1) of this section as required by §60.5160(b), including the date of the initial review and all subsequent annual reviews.

(ii) Records showing the names of the SSI operators who have completed the operator training requirements under §60.5130, met the criteria for qualification under §60.5140, and maintained or renewed their qualification under §60.5145 or §60.5150. Records must include documentation of training, including the dates of their initial qualification and all subsequent renewals of such qualifications.

(3) Records showing the periods when no qualified operators were accessible for more than 8 hours, but less than 2 weeks, as required in §60.5155(a).

(4) Records showing the periods when no qualified operators were accessible for 2 weeks or more along with copies of reports submitted as required in §60.5155(b).

(d) *Air pollution control device inspections.* Records of the results of initial and annual air pollution control device inspections conducted as specified in §§60.5195 and 60.5220(c), including any required maintenance and any repairs not completed within 10 days of an inspection or the timeframe established by the Administrator.

(e) *Performance test reports.* (1) The results of the initial, annual, and any subsequent performance tests conducted to determine compliance with the emission limits and standards and/or to establish operating limits, as applicable.

(2) Retain a copy of the complete performance test report, including calculations.

(3) Keep a record of the hourly dry sludge feed rate measured during performance test runs as specified in §60.5220(a)(2)(i).

(4) Keep any necessary records to demonstrate that the performance test was conducted under conditions representative of normal operations, including a record of the moisture content measured as required in §60.5220(a)(2)(ii) for each grab sample taken of the sewage sludge burned during the performance test.

(f) *Continuous monitoring data.* Records of the following data, as applicable:

(1) For continuous emissions monitoring systems, all 1-hour average concentrations of particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans total mass basis, mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead emissions.

(2) For continuous automated sampling systems, all average concentrations measured for mercury and dioxins/furans total mass basis at the frequencies specified in your monitoring plan.

(3) For continuous parameter monitoring systems:

(i) All 1-hour average values recorded for the following operating parameters, as applicable:

(A) Combustion chamber operating temperature (or afterburner temperature).

(B) If a wet scrubber is used to comply with the rule, pressure drop across each wet scrubber system and liquid flow rate to each wet scrubber used to comply with the emission limit in Table 2 or 3 to this subpart for particulate matter, cadmium, or lead, and scrubber liquid flow rate and scrubber liquid pH for each wet scrubber used to comply with an emission limit in Table 2 or 3 to this subpart for sulfur dioxide or hydrogen chloride.

(C) If an electrostatic precipitator is used to comply with the rule, secondary voltage of the electrostatic precipitator collection plates and secondary amperage of the electrostatic precipitator collection plates, and effluent water flow rate at the outlet of the wet electrostatic precipitator.

(D) If activated carbon injection is used to comply with the rule, sorbent flow rate and carrier gas flow rate or pressure drop, as applicable.

(ii) All daily average values recorded for the feed rate and moisture content of the sewage sludge fed to the sewage sludge incinerator, monitored and calculated as specified in §60.5170(f).

(iii) If a fabric filter is used to comply with the rule, the date, time, and duration of each alarm and the time corrective action was initiated and completed, and a brief description of the cause of the alarm and the corrective action taken. You must also record the percent of operating time during each 6-month period that the alarm sounds, calculated as specified in §60.5210.

(iv) For other control devices for which you must establish operating limits under §60.5175, you must maintain data collected for all operating parameters used to determine compliance with the operating limits, at the frequencies specified in your monitoring plan.

(g) *Other records for continuous monitoring systems.* You must keep the following records, as applicable:

(1) Keep records of any notifications to the Administrator in §60.4915(h)(1) of starting or stopping use of a continuous monitoring system for determining compliance with any emissions limit.

(2) Keep records of any requests under §60.5220(b)(5) that compliance with the emission limits be determined using carbon dioxide measurements corrected to an equivalent of 7 percent oxygen.

(3) If activated carbon injection is used to comply with the rule, the type of sorbent used and any changes in the type of sorbent used.

(h) *Deviation Reports.* Records of any deviation reports submitted under §60.5235(e) and (f).

(i) *Equipment specifications and operation and maintenance requirements.* Equipment specifications and related operation and maintenance requirements received from vendors for the incinerator, emission controls, and monitoring equipment.

(j) *Inspections, calibrations, and validation checks of monitoring devices.* Records of inspections, calibration, and validation checks of any monitoring devices as required under §§60.5220 and 60.5225.

(k) *Monitoring plan and performance evaluations for continuous monitoring systems.* Records of the monitoring plans required under §60.5200, and records of performance evaluations required under §60.5205(b)(5).(l) *Less frequent testing.* If, consistent with 60.5205(a)(3), you elect to conduct performance tests less frequently than annually, you must keep annual records that document that your emissions in the two previous consecutive years were at or below 75 percent of the applicable emission limit in Table 1 or 2 to this subpart, and document that there were no changes in source operations or air pollution control equipment that would cause emissions of the relevant pollutant to increase within the past 2 years.

(m) *Use of bypass stack.* Records indicating use of the bypass stack, including dates, times, and durations as required under §60.5225(d).

(n) If a malfunction occurs, you must keep a record of the information submitted in your annual report in §60.5235(c)(16).

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§60.5235 What reports must I submit?

You must submit the reports specified in paragraphs (a) through (i) of this section. See Table 6 to this subpart for a summary of these reports.

(a) *Increments of progress report.* If you plan to achieve compliance more than 1 year following the effective date of state plan approval, you must submit the following reports, as applicable:

(1) A final control plan as specified in §§60.5085(a) and 60.5110.

(2) You must submit your notification of achievement of increments of progress no later than 10 business days after the compliance date for the increment as specified in §§60.5095 and 60.5100.

(3) If you fail to meet an increment of progress, you must submit a notification to the Administrator postmarked within 10 business days after the date for that increment, as specified in §60.5105.

(4) If you plan to close your SSI unit rather than comply with the state plan, submit a closure notification as specified in §60.5125.

(b) *Initial compliance report.* You must submit the following information no later than 60 days following the initial performance test.

(1) Company name, physical address, and mailing address.

(2) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(3) Date of report.

(4) The complete test report for the initial performance test results obtained by using the test methods specified in Table 2 or 3 to this subpart.

(5) If an initial performance evaluation of a continuous monitoring system was conducted, the results of that initial performance evaluation.

(6) The values for the site-specific operating limits established pursuant to §§60.5170 and 60.5175 and the calculations and methods, as applicable, used to establish each operating limit.

(7) If you are using a fabric filter to comply with the emission limits, documentation that a bag leak detection system has been installed and is being operated, calibrated, and maintained as required by §60.5170(b).

(8) The results of the initial air pollution control device inspection required in §60.5195, including a description of repairs.

(9) The site-specific monitoring plan required under §60.5200, at least 60 days before your initial performance evaluation of your continuous monitoring system.

(10) The site-specific monitoring plan for your ash handling system required under §60.5200, at least 60 days before your initial performance test to demonstrate compliance with your fugitive ash emission limit.

(c) *Annual compliance report.* You must submit an annual compliance report that includes the items listed in paragraphs (c)(1) through (c)(16) of this section for the reporting period specified in paragraph (c)(3) of this section. You must submit your first annual compliance report no later than 12 months following the submission of the initial compliance report in paragraph (b) of this section. You must submit subsequent annual compliance reports no more than 12 months following the previous annual compliance report. (You may be required to submit these reports (or additional compliance information) more frequently by the title V operating permit required in §60.5240.)

(1) Company name, physical address, and mailing address.

(2) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(3) Date of report and beginning and ending dates of the reporting period.

(4) If a performance test was conducted during the reporting period, the results of that performance test.

(i) If operating limits were established during the performance test, include the value for each operating limit and, as applicable, the method used to establish each operating limit, including calculations.

(ii) If activated carbon is used during the performance test, include the type of activated carbon used.

(5) For each pollutant and operating parameter recorded using a continuous monitoring system, the highest average value and lowest average value recorded during the reporting period, as follows:

(i) For continuous emission monitoring systems and continuous automated sampling systems, report the highest and lowest 24-hour average emission value.

(ii) For continuous parameter monitoring systems, report the following values:

(A) For all operating parameters except scrubber liquid pH, the highest and lowest 12-hour average values.

(B) For scrubber liquid pH, the highest and lowest 3-hour average values.

(6) If there are no deviations during the reporting period from any emission limit, emission standard, or operating limit that applies to you, a statement that there were no deviations from the emission limits, emission standard, or operating limits.

(7) Information for bag leak detection systems recorded under §60.5230(f)(3)(iii).

(8) If a performance evaluation of a continuous monitoring system was conducted, the results of that performance evaluation. If new operating limits were established during the performance evaluation, include your calculations for establishing those operating limits.

(9) If you elect to conduct performance tests less frequently as allowed in §60.5205(a)(3) and did not conduct a performance test during the reporting period, you must include the dates of the last two performance tests, a comparison of the emission level you achieved in the last two performance tests to the 75 percent emission limit threshold specified in §60.5205(a)(3), and a statement as to whether there have been any process changes and whether the process change resulted in an increase in emissions.

(10) Documentation of periods when all qualified sewage sludge incineration unit operators were unavailable for more than 8 hours, but less than 2 weeks.

(11) Results of annual air pollution control device inspections recorded under §60.5230(d) for the reporting period, including a description of repairs.

(12) If there were no periods during the reporting period when your continuous monitoring systems had a malfunction, a statement that there were no periods during which your continuous monitoring systems had a malfunction.

(13) If there were no periods during the reporting period when a continuous monitoring system was out of control, a statement that there were no periods during which your continuous monitoring systems were out of control.

(14) If there were no operator training deviations, a statement that there were no such deviations during the reporting period.

(15) If you did not make revisions to your site-specific monitoring plan during the reporting period, a statement that you did not make any revisions to your site-specific monitoring plan during the reporting period. If you made revisions to your site-specific monitoring plan during the reporting period, a copy of the revised plan.

(16) If you had a malfunction during the reporting period, the compliance report must include the number, duration, and a brief description for each type of malfunction that occurred during the reporting period and that caused or may have caused any

applicable emission limitation to be exceeded. The report must also include a description of actions taken by an owner or operator during a malfunction of an affected source to minimize emissions in accordance with §60.11(d), including actions taken to correct a malfunction.

(d) *Deviation reports.* (1) You must submit a deviation report if:

(i) Any recorded operating parameter level, based on the averaging time specified in Table 4 to this subpart, is above the maximum operating limit or below the minimum operating limit established under this subpart.

(ii) The bag leak detection system alarm sounds for more than 5 percent of the operating time for the 6-month reporting period.

(iii) Any recorded 24-hour block average emissions level is above the emission limit, if a continuous monitoring system is used to comply with an emission limit.

(iv) There are visible emissions of combustion ash from an ash conveying system for more than 5 percent of the hourly observation period.

(v) A performance test was conducted that deviated from any emission limit in Table 2 or 3 to this subpart.

(vi) A continuous monitoring system was out of control.

(vii) You had a malfunction (*e.g.,* continuous monitoring system malfunction) that caused or may have caused any applicable emission limit to be exceeded.

(2) The deviation report must be submitted by August 1 of that year for data collected during the first half of the calendar year (January 1 to June 30), and by February 1 of the following year for data you collected during the second half of the calendar year (July 1 to December 31).

(3) For each deviation where you are using a continuous monitoring system to comply with an associated emission limit or operating limit, report the items described in paragraphs (d)(3)(i) through (d)(3)(viii) of this section.

(i) Company name, physical address, and mailing address.

(ii) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(iii) The calendar dates and times your unit deviated from the emission limits, emission standards, or operating limits requirements.

(iv) The averaged and recorded data for those dates.

(v) Duration and cause of each deviation from the following:

(A) Emission limits, emission standards, operating limits, and your corrective actions.

(B) Bypass events and your corrective actions.

(vi) Dates, times, and causes for monitor downtime incidents.

(vii) A copy of the operating parameter monitoring data during each deviation and any test report that documents the emission levels.

(viii) If there were periods during which the continuous monitoring system malfunctioned or was out of control, you must include the following information for each deviation from an emission limit or operating limit:

(A) The date and time that each malfunction started and stopped.

(B) The date, time, and duration that each continuous monitoring system was inoperative, except for zero (low-level) and high-level checks.

(C) The date, time, and duration that each continuous monitoring system was out of control, including start and end dates and hours and descriptions of corrective actions taken.

(D) The date and time that each deviation started and stopped, and whether each deviation occurred during a period of malfunction, during a period when the system as out of control, or during another period.

(E) A summary of the total duration of the deviation during the reporting period, and the total duration as a percent of the total source operating time during that reporting period.

(F) A breakdown of the total duration of the deviations during the reporting period into those that are due to control equipment problems, process problems, other known causes, and other unknown causes.

(G) A summary of the total duration of continuous monitoring system downtime during the reporting period, and the total duration of continuous monitoring system downtime as a percent of the total operating time of the SSI unit at which the continuous monitoring system downtime occurred during that reporting period.

(H) An identification of each parameter and pollutant that was monitored at the SSI unit.

(I) A brief description of the SSI unit.

(J) A brief description of the continuous monitoring system.

(K) The date of the latest continuous monitoring system certification or audit.

(L) A description of any changes in continuous monitoring system, processes, or controls since the last reporting period.

(4) For each deviation where you are not using a continuous monitoring system to comply with the associated emission limit or operating limit, report the following items:

(i) Company name, physical address, and mailing address.

(ii) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(iii) The total operating time of each affected source during the reporting period.

(iv) The calendar dates and times your unit deviated from the emission limits, emission standards, or operating limits requirements.

(v) The averaged and recorded data for those dates.

(vi) Duration and cause of each deviation from the following:

(A) Emission limits, emission standards, operating limits, and your corrective actions.

(B) Bypass events and your corrective actions.

(vii) A copy of any performance test report that showed a deviation from the emission limits or standards.

(viii) A brief description of any malfunction reported in paragraph (d)(1)(vii) of this section, including a description of actions taken during the malfunction to minimize emissions in accordance with §60.11(d) and to correct the malfunction.

(e) *Qualified operator deviation.* (1) If all qualified operators are not accessible for 2 weeks or more, you must take the two actions in paragraphs (e)(1)(i) and (e)(1)(ii) of this section.

(i) Submit a notification of the deviation within 10 days that includes the three items in paragraphs (e)(1)(i)(A) through (e)(1)(i)(C) of this section.

(A) A statement of what caused the deviation.

(B) A description of actions taken to ensure that a qualified operator is accessible.

(C) The date when you anticipate that a qualified operator will be available.

(ii) Submit a status report to the Administrator every 4 weeks that includes the three items in paragraphs (e)(1)(ii)(A) through (e)(1)(ii)(C) of this section.

(A) A description of actions taken to ensure that a qualified operator is accessible.

(B) The date when you anticipate that a qualified operator will be accessible.

(C) Request for approval from the Administrator to continue operation of the SSI unit.

(2) If your unit was shut down by the Administrator, under the provisions of §60.5155(b)(2)(i), due to a failure to provide an accessible qualified operator, you must notify the Administrator within five days of meeting §60.5155(b)(2)(ii) that you are resuming operation.

(f) *Notification of a force majeure.* If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure:

(1) You must notify the Administrator, in writing as soon as practicable following the date you first knew, or through due diligence, should have known that the event may cause or caused a delay in conducting a performance test beyond the regulatory deadline, but the notification must occur before the performance test deadline unless the initial force majeure or a subsequent force majeure event delays the notice, and in such cases, the notification must occur as soon as practicable.

(2) You must provide to the Administrator a written description of the force majeure event and a rationale for attributing the delay in conducting the performance test beyond the regulatory deadline to the force majeure; describe the measures taken or to be taken to minimize the delay; and identify a date by which you propose to conduct the performance test.

(g) *Other notifications and reports required.* You must submit other notifications as provided by §60.7 and as follows:

(1) You must notify the Administrator 1 month before starting or stopping use of a continuous monitoring system for determining compliance with any emission limit.

(2) You must notify the Administrator at least 30 days prior to any performance test conducted to comply with the provisions of this subpart, to afford the Administrator the opportunity to have an observer present.

(3) As specified in §60.5220(a)(8), you must notify the Administrator at least 7 days prior to the date of a rescheduled performance test for which notification was previously made in paragraph (g)(2) of this section.

(h) *Report submission form.* (1) Submit initial, annual, and deviation reports electronically or in paper format, postmarked on or before the submittal due dates.

(2) As of January 1, 2012 and within 60 days after the date of completing each performance test, as defined in §63.2, conducted to demonstrate compliance with this subpart, you must submit relative accuracy test audit (*i.e.,* reference method) data and performance test (*i.e.,* compliance test) data, except opacity data, electronically to EPA's Central Data Exchange (CDX) by using the Electronic Reporting Tool (ERT) (*see http://www.epa.gov/ttn/chief/ert/ert____tool.html/*) or other compatible electronic spreadsheet. Only data collected using test methods compatible with ERT are subject to this requirement to be submitted electronically into EPA's WebFIRE database.

(i) *Changing report dates.* If the Administrator agrees, you may change the semiannual or annual reporting dates. See §60.19(c) for procedures to seek approval to change your reporting date.

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MODEL RULE—TITLE V OPERATING PERMITS

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§60.5240 Am I required to apply for and obtain a Title V operating permit for my existing SSI unit?

Yes, if you are subject to an applicable EPA-approved and effective CAA section 111(d)/129 state or tribal plan or an applicable and effective Federal plan, you are required to apply for and obtain a Title V operating permit for your existing SSI unit unless you meet the relevant requirements for an exemption specified in §60.5065.

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§60.5245 When must I submit a title V permit application for my existing SSI unit?

(a) If your existing SSI unit is not subject to an earlier permit application deadline, a complete title V permit application must be submitted on or before the earlier of the dates specified in paragraphs (a)(1) through (a)(3) of this section. (See sections 129 (e), 503(c), 503(d), and 502(a) of the Clean Air Act and 40 CFR 70.5(a)(1)(i) and 40 CFR 71.5(a)(1)(i)).

(1) 12 months after the effective date of any applicable EPA-approved Clean Air Act section 111(d)/129 state or tribal plan.

(2) 12 months after the effective date of any applicable Federal plan.

(3) March 21, 2014.

(b) For any existing unit not subject to an earlier permit application deadline, the application deadline of 36 months after the promulgation of this subpart applies regardless of whether or when any applicable Federal plan is effective, or whether or when any applicable Clean Air Act section 111(d)/129 state or tribal plan is approved by EPA and becomes effective.

(c) If your existing unit is subject to title V as a result of some triggering requirement(s) other than those specified in paragraphs (a) and (b) of this section (for example, a unit may be a major source or part of a major source), then your unit may be required to apply for a title V permit prior to the deadlines specified in paragraphs (a) and (b). If more than one requirement triggers a source's obligation to apply for a title V permit, the 12-month timeframe for filing a title V permit application is triggered by the requirement which first causes the source to be subject to title V. (See section 503(c) of the Clean Air Act and 40 CFR 70.3(a) and (b), 40 CFR 70.5(a)(1)(i), 40 CFR 71.3(a) and (b), and 40 CFR 71.5(a)(1)(i).)

(d) A “complete” title V permit application is one that has been determined or deemed complete by the relevant permitting authority under section 503(d) of the Clean Air Act and 40 CFR 70.5(a)(2) or 40 CFR 71.5(a)(2). You must submit a complete permit application by the relevant application deadline in order to operate after this date in compliance with Federal law. (*See* sections 503(d) and 502(a) of the Clean Air Act and 40 CFR 70.7(b) and 40 CFR 71.7(b).)

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MODEL RULE-DEFINITIONS

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§60.5250 What definitions must I know?

Terms used but not defined in this subpart are defined in the Clean Air Act and §60.2.

Administrator means:

(1) For units covered by the Federal plan, the Administrator of the EPA or his/her authorized representative.

(2) For units covered by an approved state plan, the director of the state air pollution control agency or his/her authorized representative.

Affected source means a sewage sludge incineration unit as defined in §60.5250.

Affirmative defense means, in the context of an enforcement proceeding, a response or defense put forward by a defendant, regarding which the defendant has the burden of proof, and the merits of which are independently and objectively evaluated in a judicial or administrative proceeding.

Auxiliary fuel means natural gas, liquefied petroleum gas, fuel oil, or diesel fuel.

Bag leak detection system means an instrument that is capable of monitoring particulate matter loadings in the exhaust of a fabric filter (*i.e.,* baghouse) in order to detect bag failures. A bag leak detection system includes, but is not limited to, an instrument that operates on triboelectric, light scattering, light transmittance, or other principle to monitor relative particulate matter loadings.

Bypass stack means a device used for discharging combustion gases to avoid severe damage to the air pollution control device or other equipment.

Calendar year means 365 consecutive days starting on January 1 and ending on December 31.

Continuous automated sampling system means the total equipment and procedures for automated sample collection and sample recovery/analysis to determine a pollutant concentration or emission rate by collecting a single integrated sample(s) or multiple integrated sample(s) of the pollutant (or diluent gas) for subsequent on- or off-site analysis; integrated sample(s) collected are representative of the emissions for the sample time as specified by the applicable requirement.

Continuous emissions monitoring system means a monitoring system for continuously measuring and recording the emissions of a pollutant from an affected facility.

Continuous monitoring system (CMS) means a continuous emissions monitoring system, continuous automated sampling system, continuous parameter monitoring system or other manual or automatic monitoring that is used for demonstrating compliance with an applicable regulation on a continuous basis as defined by this subpart. The term refers to the total equipment used to sample and condition (if applicable), to analyze, and to provide a permanent record of emissions or process parameters.

Continuous parameter monitoring system means a monitoring system for continuously measuring and recording operating conditions associated with air pollution control device systems (*e.g.,* operating temperature, pressure, and power).

Deviation means any instance in which an affected source subject to this subpart, or an owner or operator of such a source:

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emission limit, operating limit, or operator qualification and accessibility requirements.

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit.

Dioxins/furans means tetra- through octa-chlorinated dibenzo-p-dioxins and dibenzofurans.

Electrostatic precipitator or wet electrostatic precipitator means an air pollution control device that uses both electrical forces and, if applicable, water to remove pollutants in the exit gas from a sewage sludge incinerator stack.

Existing sewage sludge incineration unit means a sewage sludge incineration unit the construction of which is commenced on or before October 14, 2010.

Fabric filter means an add-on air pollution control device used to capture particulate matter by filtering gas streams through filter media, also known as a baghouse.

Fluidized bed incinerator means an enclosed device in which organic matter and inorganic matter in sewage sludge are combusted in a bed of particles suspended in the combustion chamber gas.

Malfunction means any sudden, infrequent, and not reasonably preventable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner. Failures that are caused, in part, by poor maintenance or careless operation are not malfunctions.

Modification means a change to an existing SSI unit later than September 21, 2011 and that meets one of two criteria:

(1) The cumulative cost of the changes over the life of the unit exceeds 50 percent of the original cost of building and installing the SSI unit (not including the cost of land) updated to current costs (current dollars). To determine what systems are within the boundary of the SSI unit used to calculate these costs, see the definition of SSI unit.

(2) Any physical change in the SSI unit or change in the method of operating it that increases the amount of any air pollutant emitted for which section 129 or section 111 of the Clean Air Act has established standards.

Modified sewage sludge incineration unit means an existing SSI unit that undergoes a modification, as defined in this section.

Multiple hearth incinerator means a circular steel furnace that contains a number of solid refractory hearths and a central rotating shaft; rabble arms that are designed to slowly rake the sludge on the hearth are attached to the rotating shaft. Dewatered sludge enters at the top and proceeds downward through the furnace from hearth to hearth, pushed along by the rabble arms.

Operating day means a 24-hour period between 12:00 midnight and the following midnight during which any amount of sewage sludge is combusted at any time in the SSI unit.

Particulate matter means filterable particulate matter emitted from SSI units as measured by Method 5 at 40 CFR part 60, appendix A-3 or Methods 26A or 29 at 40 CFR part 60, appendix A-8.

Power input to the electrostatic precipitator means the product of the test-run average secondary voltage and the test-run average secondary amperage to the electrostatic precipitator collection plates.

Process change means a significant permit revision, but only with respect to those pollutant-specific emission units for which the proposed permit revision is applicable, including but not limited to:

(1) A change in the process employed at the wastewater treatment facility associated with the affected SSI unit (*e.g.,* the addition of tertiary treatment at the facility, which changes the method used for disposing of process solids and processing of the sludge prior to incineration).

(2) A change in the air pollution control devices used to comply with the emission limits for the affected SSI unit (*e.g.,* change in the sorbent used for activated carbon injection).

Sewage sludge means solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incineration unit or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

Sewage sludge feed rate means the rate at which sewage sludge is fed into the incinerator unit.

Sewage sludge incineration (SSI) unit means an incineration unit combusting sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. Sewage sludge incineration unit designs include fluidized bed and multiple hearth. A SSI unit also includes, but is not limited to, the sewage sludge feed system, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The SSI unit includes all ash handling systems connected to the bottom ash handling system. The combustion unit bottom ash system ends at the truck loading station or similar equipment that transfers the ash to final disposal. The SSI unit does not include air pollution control equipment or the stack.

Shutdown means the period of time after all sewage sludge has been combusted in the primary chamber.

Solid waste means any garbage, refuse, sewage sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1342), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (42 U.S.C. 2014).

Standard conditions, when referring to units of measure, means a temperature of 68 °F (20 °C) and a pressure of 1 atmosphere (101.3 kilopascals).

Startup means the period of time between the activation, including the firing of fuels (*e.g.,* natural gas or distillate oil), of the system and the first feed to the unit.

Toxic equivalency means the product of the concentration of an individual dioxin isomer in an environmental mixture and the corresponding estimate of the compound-specific toxicity relative to tetrachlorinated dibenzo-p-dioxin, referred to as the toxic equivalency factor for that compound. Table 5 to this subpart lists the toxic equivalency factors.

Wet scrubber means an add-on air pollution control device that utilizes an aqueous or alkaline scrubbing liquid to collect particulate matter (including nonvaporous metals and condensed organics) and/or to absorb and neutralize acid gases.

You means the owner or operator of an affected SSI unit.

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Table 1 to Subpart MMMM of Part 60—Model Rule—Increments of Progress and Compliance Schedules for Existing Sewage Sludge Incineration Units

Comply with these increments of progress	By these dates[a]
Increment 1—Submit final control plan	(Dates to be specified in state plan)
Increment 2—Final compliance	(Dates to be specified in state plan)[b]

[a]Site-specific schedules can be used at the discretion of the state.

[b]The date can be no later than 3 years after the effective date of state plan approval or March 21, 2016 for SSI units that commenced construction on or before October 14, 2010.

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Table 2 to Subpart MMMM of Part 60—Model Rule—Emission Limits and Standards for Existing Fluidized Bed Sewage Sludge Incineration Units

For the air pollutant	You must meet this emission limit[a]	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Particulate matter	18 milligrams per dry standard cubic meter	3-run average (collect a minimum volume of 1 dry standard cubic meters sample per run)	Performance test (Method 5 at 40 CFR part 60, appendix A-3; Method 26A or Method 29 at 40 CFR part 60, appendix A-8).
Hydrogen chloride	0.51 parts per million by dry volume	3-run average (Collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 26A at 40 CFR part 60, appendix A-8).
Carbon monoxide	64 parts per million by dry volume	3-run average (collect sample for a minimum duration of one hour per run)	Performance test (Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4).
Dioxins/furans (total mass basis); or Dioxins/furans (toxic equivalency basis)[b]	1.2 nanograms per dry standard cubic meter (total mass basis); or 0.10 nanograms per dry standard cubic meter (toxic equivalency basis)	3-run average (collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 23 at 40 CFR part 60, appendix A-7).
Mercury	0.037 milligrams per dry standard cubic meter	3-run average (For Method 29 and ASTM D6784-02 (Reapproved 2008)[c], collect a minimum volume of 1 dry standard cubic meters per run. For Method 30B, collect a minimum sample as specified in Method 30B at 40 CFR part 60, appendix A-8)	Performance test (Method 29 at 40 CFR part 60, appendix A-8; Method 30B at 40 CFR part 60, appendix A-8; or ASTM D6784-02 (Reapproved 2008).[c]
Oxides of nitrogen	150 parts per million by dry volume	3-run average (Collect sample for a minimum duration of one hour per run)	Performance test (Method 7 or 7E at 40 CFR part 60, appendix A-4).
Sulfur dioxide	15 parts per million by dry volume	3-run average (For Method 6, collect a minimum volume of 60 liters per run. For Method 6C, collect sample for a minimum duration of one hour per run)	Performance test (Method 6 or 6C at 40 CFR part 40, appendix A-4; or ANSI/ASME PTC-19.10-1981.[c]
Cadmium	0.0016 milligrams per dry standard cubic meter	3-run average (collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 29 at 40 CFR part 60, appendix A-8). Use GFAAS or ICP/MS for the analytical finish.
Lead	0.0074 milligrams per dry standard cubic meter	3-run average (collect a minimum volume of 1 dry standard cubic meters sample per run)	

			Performance test (Method 29 at 40 CFR part 60, appendix A-8. Use GFAAS or ICP/MS for the analytical finish.
Fugitive emissions from ash handling	Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) for no more than 5 percent of the hourly observation period	Three 1-hour observation periods	Visible emission test (Method 22 of appendix A-7 of this part).

[a] All emission limits are measured at 7 percent oxygen, dry basis at standard conditions.

[b] You have the option to comply with either the dioxin/furan emission limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

[c] Incorporated by reference, *see* §60.17.

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Table 3 to Subpart MMMM of Part 60—Model Rule—Emission Limits and Standards for Existing Multiple Hearth Sewage Sludge Incineration Units

For the air pollutant	You must meet this emission limit[a]	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Particulate matter	80 milligrams per dry standard cubic meter	3-run average (collect a minimum volume of 0.75 dry standard cubic meters per run)	Performance test (Method 5 at 40 CFR part 60, appendix A-3; Method 26A or Method 29 at 40 CFR part 60, appendix A-8).
Hydrogen chloride	1.2 parts per million by dry volume	3-run average (For Method 26, collect a minimum volume of 200 liters per run. For Method 26A, collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 26 or 26A at 40 CFR part 60, appendix A-8).
Carbon monoxide	3,800 parts per million by dry volume	3-run average (collect sample for a minimum duration of one hour per run)	Performance test (Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4).
Dioxins/furans (total mass basis)	5.0 nanograms per dry standard cubic meter; or	3-run average (collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 23 at 40 CFR part 60, appendix A-7).
Dioxins/furans (toxic equivalency basis)[b]	0.32 nanograms per dry standard cubic meter		
Mercury	0.28 milligrams per dry standard cubic meter	3-run average (For Method 29 and ASTM D6784-02 (Reapproved 2008),[c] collect a minimum volume of 1 dry standard cubic meters per run. For Method 30B, collect a minimum sample as specified in Method 30B at 40 CFR part 60, appendix A-8)	Performance test (Method 29 at 40 CFR part 60, appendix A-8; Method 30B at 40 CFR part 60, appendix A-8; or ASTM D6784-02 (Reapproved 2008)).[c]
Oxides of nitrogen	220 parts per million by dry volume	3-run average (Collect sample for a minimum duration of one hour per run)	Performance test (Method 7 or 7E at 40 CFR part 60, appendix A-4).
Sulfur dioxide	26 parts per million by dry volume	3-run average (For Method 6, collect a minimum volume of 200 liters per run. For Method 6C, collect sample for a minimum duration of one hour per run)	Performance test (Method 6 or 6C at 40 CFR part 40, appendix A-4; or ANSI/ASME PTC 19.10-1981).[c]
Cadmium	0.095 milligrams per dry standard cubic meter	3-run average (collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 29 at 40 CFR part 60, appendix A-8).
Lead	0.30 milligrams per dry standard cubic meter	3-run average (collect a minimum volume of 1 dry standard cubic meters per run)	Performance test (Method 29 at 40 CFR part 60, appendix A-8).
Fugitive emissions from ash handling	Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) for no more than 5 percent of the hourly observation period	Three 1-hour observation periods	Visible emission test (Method 22 of appendix A-7 of this part).

[a]All emission limits are measured at 7 percent oxygen, dry basis at standard conditions.

[b]You have the option to comply with either the dioxin/furan emission limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

[c]Incorporated by reference, *see* §60.17.

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Table 4 to Subpart MMMM of Part 60—Model Rule—Operating Parameters for Existing Sewage Sludge Incineration Units[a]

For these operating parameters	You must establish these operating limits	And monitor using these minimum frequencies		
		Data measurement	Data recording[b]	Data averaging period for compliance
All sewage sludge incineration units				
Combustion chamber operating temperature (not required if afterburner temperature is monitored)	Minimum combustion chamber operating temperature or afterburner temperature	Continuous	Every 15 minutes	12-hour block.

Fugitive emissions from ash handling	Site-specific operating requirements	Not applicable	No applicable	Not applicable.
Scrubber				
Pressure drop across each wet scrubber	Minimum pressure drop	Continuous	Every 15 minutes	12-hour block.
Scrubber liquid flow rate	Minimum flow rate	Continuous	Every 15 minutes	12-hour block.
Scrubber liquid pH	Minimum pH	Continuous	Every 15 minutes	3-hour block.
Fabric Filter				
Alarm time of the bag leak detection system alarm	Maximum alarm time of the bag leak detection system alarm (this operating limit is provided in §60.4850 and is not established on a site-specific basis)			
Electrostatic precipitator				
Secondary voltage of the electrostatic precipitator collection plates	Minimum power input to the electrostatic precipitator collection plates	Continuous	Hourly	12-hour block.
Secondary amperage of the electrostatic precipitator collection plates				
Effluent water flow rate at the outlet of the electrostatic precipitator	Minimum effluent water flow rate at the outlet of the electrostatic precipitator	Hourly	Hourly	12-hour block.
Activated carbon injection				
Mercury sorbent injection rate	Minimum mercury sorbent injection rate	Hourly	Hourly	12-hour block.
Dioxin/furan sorbent injection rate	Minimum dioxin/furan sorbent injection rate			
Carrier gas flow rate or carrier gas pressure drop	Minimum carrier gas flow rate or minimum carrier gas pressure drop	Continuous	Every 15 minutes	12-hour block.
Afterburner				
Temperature of the afterburner combustion chamber	Minimum temperature of the afterburner combustion chamber	Continuous	Every 15 minutes	12-hour block.

[a]As specified in §60.5190, you may use a continuous emissions monitoring system or continuous automated sampling system in lieu of establishing certain operating limits.

[b]This recording time refers to the minimum frequency that the continuous monitor or other measuring device initially records data. For all data recorded every 15 minutes, you must calculate hourly arithmetic averages. For all parameters, you use hourly averages to calculate the 12-hour or 3-hour block average specified in this table for demonstrating compliance. You maintain records of 1-hour averages.

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Table 5 to Subpart MMMM of Part 60—Model Rule—Toxic Equivalency Factors

Dioxin/furan isomer	Toxic equivalency factor
2,3,7,8-tetrachlorinated dibenzo-p-dioxin	1
1,2,3,7,8-pentachlorinated dibenzo-p-dioxin	1
1,2,3,4,7,8-hexachlorinated dibenzo-p-dioxin	0.1
1,2,3,7,8,9-hexachlorinated dibenzo-p-dioxin	0.1
1,2,3,6,7,8-hexachlorinated dibenzo-p-dioxin	0.1
1,2,3,4,6,7,8-heptachlorinated dibenzo-p-dioxin	0.01
octachlorinated dibenzo-p-dioxin	0.0003
2,3,7,8-tetrachlorinated dibenzofuran	0.1
2,3,4,7,8-pentachlorinated dibenzofuran	0.3
1,2,3,7,8-pentachlorinated dibenzofuran	0.03
1,2,3,4,7,8-hexachlorinated dibenzofuran	0.1
1,2,3,6,7,8-hexachlorinated dibenzofuran	0.1
1,2,3,7,8,9-hexachlorinated dibenzofuran	0.1
2,3,4,6,7,8-hexachlorinated dibenzofuran	0.1
1,2,3,4,6,7,8-heptachlorinated dibenzofuran	0.01
1,2,3,4,7,8,9-heptachlorinated dibenzofuran	0.01
octachlorinated dibenzofuran	0.0003

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Table 6 to Subpart MMMM of Part 60—Model Rule—Summary of Reporting Requirements for Existing Sewage Sludge Incineration Units[a]

Report	Due date	Contents	Reference
Increments of progress report	No later than 10 business days after the compliance date for the increment	1. Final control plan including air pollution control device descriptions, process changes, type of waste to be burned, and the maximum design sewage sludge burning capacity 2. Notification of any failure to meet an increment of progress. 3. Notification of any closure.	§60.5235 (a).
Initial compliance report	No later than 60 days following the initial performance test		

		1. Company name and address 2. Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report	§60.5235 (b).
		3. Date of report	
		4. Complete test report for the initial performance test	
		5. Results of CMS[b] performance evaluation	
		6. The values for the site-specific operating limits and the calculations and methods used to establish each operating limit	
		7. Documentation of installation of bag leak detection system for fabric filter	
		8. Results of initial air pollution control device inspection, including a description of repairs	
		9. The site-specific monitoring plan required under §60.5200	
		10. The site-specific monitoring plan for your ash handling system required under §60.5200	
Annual compliance report	No later than 12 months following the submission of the initial compliance report; subsequent reports are to be submitted no more than 12 months following the previous report	1. Company name and address 2. Statement and signature by responsible official. 3. Date and beginning and ending dates of report. 4. If a performance test was conducted during the reporting period, the results of the test, including any new operating limits and associated calculations and the type of activated carbon used, if applicable.	§60.5235 (c).
		5. For each pollutant and operating parameter recorded using a CMS, the highest recorded 3-hour average and the lowest recorded 3-hour average, as applicable	
		6. If no deviations from emission limits, emission standards, or operating limits occurred, a statement that no deviations occurred	
		7. If a fabric filter is used, the date, time, and duration of alarms	
		8. If a performance evaluation of a CMS was conducted, the results, including any new operating limits and their associated calculations	
		9. If you met the requirements of §60.5205(a)(3) and did not conduct a performance test, include the dates of the last three performance tests, a comparison to the 50 percent emission limit threshold of the emission level achieved in the last three performance tests, and a statement as to whether there have been any process changes	
		10. Documentation of periods when all qualified SSI unit operators were unavailable for more than 8 hours but less than 2 weeks	
		11. Results of annual pollutions control device inspections, including description of repairs	
		12. If there were no periods during which your CMSs had malfunctions, a statement that there were no periods during which your CMSs had malfunctions	
		13. If there were no periods during which your CMSs were out of control, a statement that there were no periods during which your CMSs were out of control	
		14. If there were no operator training deviations, a statement that there were no such deviations	
		15. Information on monitoring plan revisions, including a copy of any revised monitoring plan	
Deviation report (deviations from emission limits, emission standards, or operating limits, as specified in §60.5235(e)(1))	By August 1 of a calendar year for data collected during the first half of the calendar year; by February 1 of a calendar year for data collected during the second half of the calendar year	*If using a CMS:* 1. Company name and address. 2. Statement by a responsible official. 3. The calendar dates and times your unit deviated from the emission limits or operating limits. 4. The averaged and recorded data for those dates. 5. Duration and cause of each deviation.	§60.5235 (d).
		6. Dates, times, and causes for monitor downtime incidents	
		7. A copy of the operating parameter monitoring data during each deviation and any test report that documents the emission levels	
		8. For periods of CMS malfunction or when a CMS was out of control, you must include the information specified in §60.5235(d)(3)(viii)	
		If not using a CMS:	
		1. Company name and address	
		2. Statement by a responsible official	
		3. The total operating time of each affected SSI	
		4. The calendar dates and times your unit deviated from the emission limits, emission standard, or operating limits	

		5. The averaged and recorded data for those dates	
		6. Duration and cause of each deviation	
		7. A copy of any performance test report that showed a deviation from the emission limits or standards	
		8. A brief description of any malfunction, a description of actions taken during the malfunction to minimize emissions, and corrective action taken	
Notification of qualified operator deviation (if all qualified operators are not accessible for 2 weeks or more)	Within 10 days of deviation	1. Statement of cause of deviation 2. Description of actions taken to ensure that a qualified operator will be available. 3. The date when a qualified operator will be accessible.	§60.5235 (e).
Notification of status of qualified operator deviation	Every 4 weeks following notification of deviation	1. Description of actions taken to ensure that a qualified operator is accessible 2. The date when you anticipate that a qualified operator will be accessible. 3. Request for approval to continue operation.	§60.5235 (e).
Notification of resumed operation following shutdown (due to qualified operator deviation and as specified in §60.5155(b)(2)(i)	Within five days of obtaining a qualified operator and resuming operation	1. Notification that you have obtained a qualified operator and are resuming operation	§60.5235 (e).
Notification of a force majeure	As soon as practicable following the date you first knew, or through due diligence should have known that the event may cause or caused a delay in conducting a performance test beyond the regulatory deadline; the notification must occur before the performance test deadline unless the initial force majeure or a subsequent force majeure event delays the notice, and in such cases, the notification must occur as soon as practicable	1. Description of the force majeure event 2. Rationale for attributing the delay in conducting the performance test beyond the regulatory deadline to the force majeure 3. Description of the measures taken or to be taken to minimize the delay. 4. Identification of the date by which you propose to conduct the performance test.	§60.5235 (f).
Notification of intent to start or stop use of a CMS	1 month before starting or stopping use of a CMS	1. Intent to start or stop use of a CMS	§60.5235 (g).
Notification of intent to conduct a performance test	At least 30 days prior to the performance test	1. Intent to conduct a performance test to comply with this subpart	
Notification of intent to conduct a rescheduled performance test	At least 7 days prior to the date of a rescheduled performance test	1. Intent to conduct a rescheduled performance test to comply with this subpart	

[a]This table is only a summary, *see* the referenced sections of the rule for the complete requirements.

[b]CMS means continuous monitoring system.

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