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Faults, Failures and Functionality of Air Sampling Pumps

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Industrial Health & Safety Instrumentation

Air Sampling Pumps – Faults, Failures and Functionality

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Abstract

The presentation will discuss the common faults, failures and functionality of today's air sampling pumps.

Additionally we will discuss methods to prevent those common faults and failures, as well as how to mitigate them prior to mobilization, and what to do when they occur when sampling.

Common Pump Components

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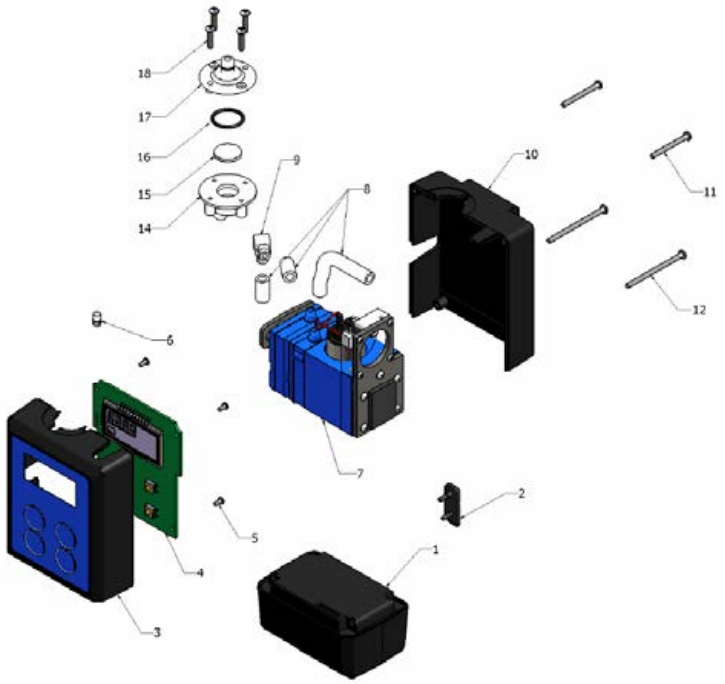
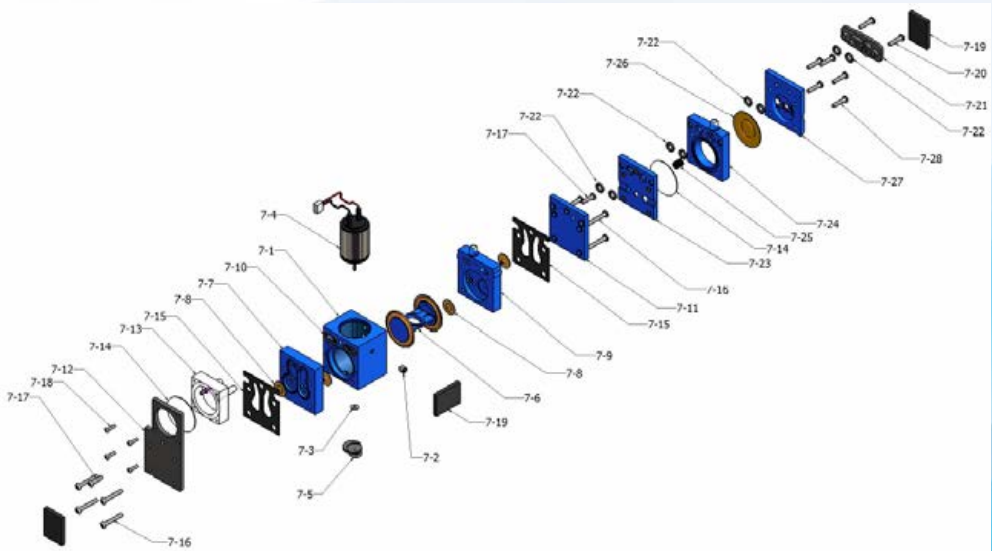
Although many of you know how a pump works, you may not have seen the inside of one..

Here are the critical components of a air sampling pump:

- **Pneumatics**
  - Motor
  - Diaphragm
  - Seals and O-rings
- **Inlet filter**
- **Battery**
- **Main Circuit Board**
  - Display
  - Key Pad

Note - various pumps will have different components that make that pump unique.





Common Faults and Failures

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Whether you are using older manual operated pumps, or the latest pump technologies, faults and pump failures will eventually occur.

The most common faults and failures are generally associated with the following:

1. Flow rate out of >5%
2. Back pressure out >10% in constant pressure
3. Back pressure out of range in constant flow
4. Back pressure over high limit
5. Battery too low

Note - various pumps will have different thresholds at which they fault out.

What Causes The Fault?

There may be numerous causes of a particular fault.

Example 1: Flow rate out of >5%

- **A pinched tubing may restrict the airflow, but not completely block it. In this case the flow rate may deviate more than 5% from the set flow rate. This may trigger a fault in your pump. In some cases the pump may continue to run, but a fault indicator will let you know that at some point the flow had deviated outside the acceptable range limits for your sampling event.**

What Causes The Fault?

There may be numerous causes of a particular fault.

Example 2: Back pressure out >10% in constant pressure setting.

- **While not all pumps have a constant pressure setting, those that do can allow for split flow sampling. This is based on holding a constant pressure. However, if there is added pressure from buildup on the cassette filters, or a pinched tube, it could cause a deviation to the pressure of more than 10%, setting the pump into fault.**

Back Pressure and Flow Rates

Back Pressure and Pump Faults

- A personal monitoring pump is working to move air against backpressure caused by the resistance of the sample media. The pump is like the car in the adjacent examples. The different types of sampling media with varying resistance to flow are like the trailers. The heavier the trailer, the harder the car has to work. The higher the backpressure, the harder the pump has to work.
- Backpressure can be effected by flow rates, filter pore size, and filter loading. To ensure your sample events do not experience pump faults, select pumps that are larger in size and have higher backpressure capabilities. The Gilian 5000, Gilian 10i, and Gilian 12 offer the highest Back Pressure capabilities of personal pumps on the market.

What Causes The Fault?

There may be numerous causes of a particular fault.

Example 3: Back pressure out of range in constant flow or over the high limit for the pump.

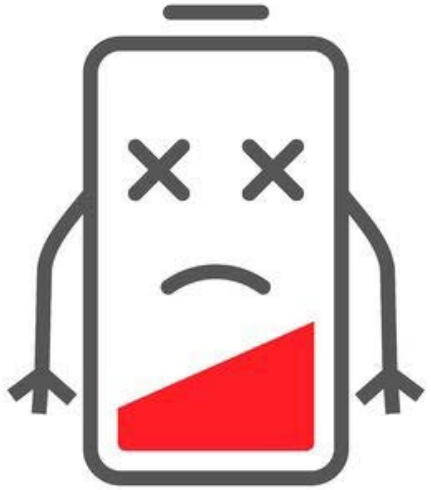
- Most modern pumps today have a stated back pressure range and limit. This is the highest back pressure the pump can run without damaging the mechanical components in the pump. For example, Our Gilian 5000 pump can pull 60 in/H2O BP at 2000 cc/min. If the back pressure were to exceed 60 in/H2O, it would fault out to protect damaging the pump.

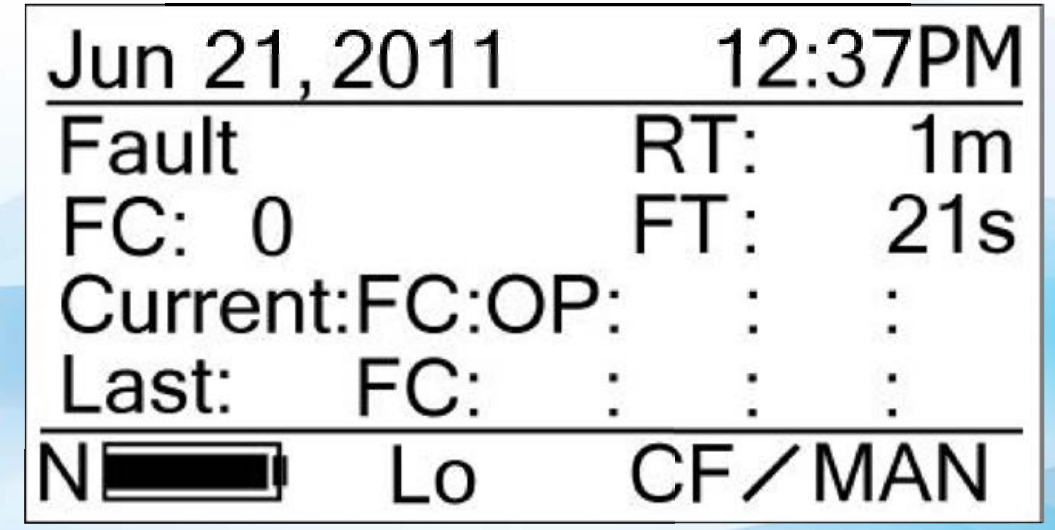
What Causes The Fault?

There may be numerous causes of a particular fault.

Example 4: Battery too low.

- Most pumps that collect data, such as run time, volume, and back pressure have internal settings to shutdown when the battery get's below a certain percentage. This occurs so it has enough power to save that information to memory. If you were in the middle of a run and this lower threshold is reached, the pump will fault and shut down. The fault will be recorded in the data log file.





Battery Maintenance

Keep Track of battery performance.

- **Sensidyne recommends replacing your battery pack within 3-years of purchase, or ~300 charging cycles.**
- **Reconditioning battery packs that are left off of charge.**
- **Reaching End of Life – battery will not run for a full shift under normal manufacture specified conditions.**

Note – All rechargeable batteries lose charge over time, even when not in use. This self discharge can be up to 1% a day.

General Info About Battery Maintenance

The GilAir Plus uses a removable, rechargeable nickel metal hydride (NiMH) battery pack. **The most common cause of lower battery life and charging issues is contaminated battery contacts.** If there is bad contact, charging may be reduced or not possible. The battery contacts can be cleaned with a pencil eraser. Never use a hard tool like a screwdriver or knife because the contacts may be damaged.

All rechargeable batteries lose charge over time even if not in use. This is called selfdischarge. **The self-discharge rate of the NiMH cells is about 1% per day.**

It is important to have the pack fully charged when starting a sample. To guarantee full charge, leave the pack or pump on the GilAir Plus charging dock until ready to use. Once the pump has charged completely, the dock will change to a trickle charge that maintains the battery at maximum capacity.

The dock will automatically perform a battery evaluation each time the battery pack is charged. Under certain conditions the dock will perform a one hour reconditioning of the battery cells to optimize the battery. If the dock detects poor battery health, a flashing LED indicates that a problem has been detected.

Tip: Daily charging is the BEST method for preserving battery life!

Choosing the Right Sampling Train

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There are several things to consider when choosing the right sampling train for your sampling event.

- **First – What Sampling Method and Media is required.**
  - **Example – NIOSH Method 7306**
    - **Sample Media – 0.8 µm pore size mixed cellulose ester (MCE) closed face 2pc, 37 mm cassette.**
    - **Flowrate 1-4 L/min (Most Common is 2 L/min)**
    - **Starting Back Pressure @ 2 L/min is ~6 in/H_2O**

NMAM

ELEMENTS by Cellulosic Internal Capsule Sampler 7306

AW: Table 1 | CAS: Table 2 | RTECS: Table 2

METHOD: 7306, Issue 1 | **EVALUATION:** FULL | **Issue 1:** 10 September 2015

OSHA PELs: Table 2
NIOSH RELs: Table 2
OTHER OELs: [1,2]

PROPERTIES: Table 1

ELEMENTS: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, indium, iron, lanthanum, lead, lithium, magnesium, manganese, molybdenum, nickel, phosphorus, potassium, selenium, silver, strontium, tin, tellurium, thallium, titanium, tungsten, vanadium, yttrium, zirconium, zinc

SAMPLING

SAMPLER: Internal capsule, cellulose acetate dome with inlet opening, attached to 0.8-µm pore size mixed cellulose ester (MCE) membrane filter and housed within a 2-piece, closed-face cassette (CFC) filter holder, 37-mm diameter

FLOWRATE: 1 to 4 L/min

VOL-MIN: Table 1
-MAX: Table 1

SHIPMENT: Routine

SAMPLE STABILITY: Stable

BLANKS: Minimum of 2 field blanks per set

ACCURACY

RANGES STUDIED: Tables 3 and 4

BIAS: Table 4

OVERALL PRECISION ($\hat{S}_{rt}$): Table 4

ACCURACY: Table 4

MEASUREMENT

TECHNIQUE: INDUCTIVELY COUPLED PLASMA – ATOMIC EMISSION SPECTROMETRY (ICP-AES)

ANALYTES: Elements above

SAMPLE DISSOLUTION: Hotplate digestion (NIOSH 7300 or 7301), microwave digestion (NIOSH 7302) or hot block extraction (NIOSH 7303)

SOLUTION: Dependent upon sample preparation method

WAVELENGTH: Depends upon element; See Table 3

BACKGROUND CORRECTION: Spectral wavelength shift

CALIBRATION: Elements in acid matrix-matched to the sample; varies depending on sample preparation method

RANGE: Varies with element

ESTIMATED LOD: Table 3

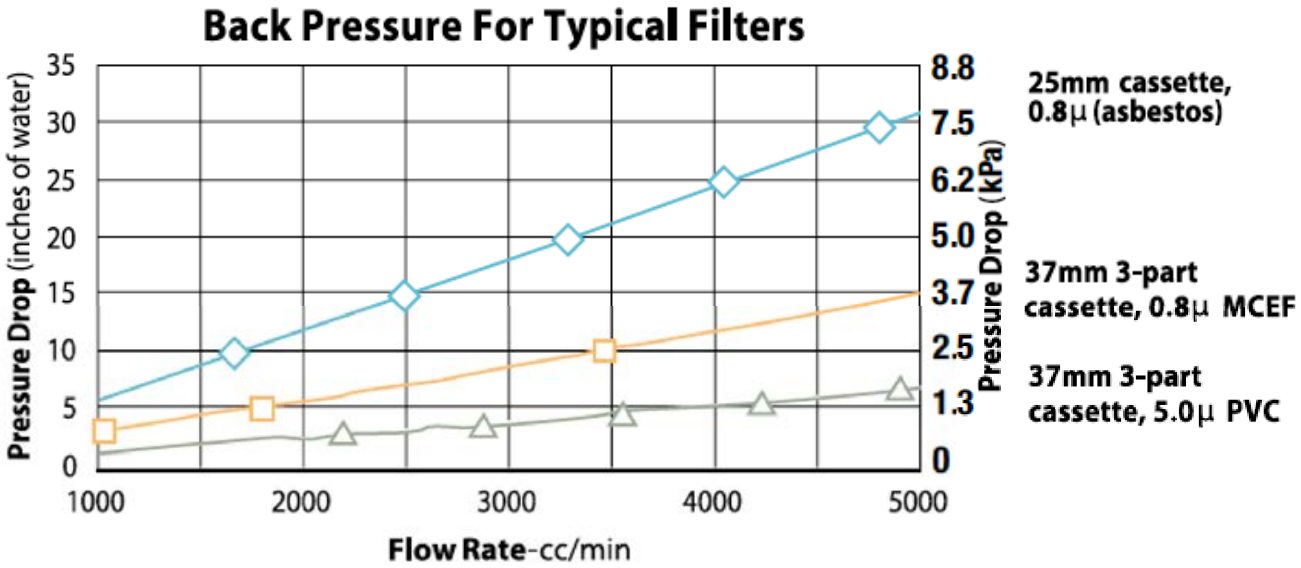
PRECISION ($\bar{S}_r$): Table 4

APPLICABILITY: The working range of this method is 4 x 10^{-5} mg/m³ to 10 mg/m³ for each element in a 500-L air sample. This is simultaneous elemental analysis, not compound specific. Verify that the types of compounds in the samples are soluble with the dissolution procedure selected. Some compounds of these elements require special sample treatment.

INTERFERNCES: Spectral interferences are the primary interferences encountered in ICP-AES analysis. These are minimized by judicious wavelength selection, interelement correction factors and background correction [3,4].

OTHER METHODS: The internal capsule sampler used in this method is a recommended alternative to filter-only sampling [5] of NIOSH methods 7300 [6], 7301 [7], 7302 [8] and 7303 [9]. Use of an internal capsule sampler is an efficient means to account for sampler wall deposits that would otherwise be excluded by filter-only sampling. Unless other means are used to account for non-filter deposits inside the cassettes (e.g. within-cassette extraction, rinsing or wiping), internal capsule samplers should be used. OSHA method ID-125G [10] describes ICP-AES multielement analysis after hotplate digestion using nitric acid, sulfuric acid and hydrogen peroxide. ASTM D7035 [11] and ISO 15202 [12] are related voluntary consensus standard ICP-AES methods for multielement sampling and analysis of workplace atmospheres.

Back Pressure and Filter Media



Flow Rate cc/min	37 mm 0.8µm/MCE	25 mm 0.8µm/MCE	37 mm 0.45µm/MCE
1000	2 inch/H_2O	6 inch/H2O	14 inch/H2O
2000	4 inch/H_2O	12 inch/H_2O	28 inch/H_2O
2500	5 inch/H_2O	15 inch/H_2O	35 inch/H_2O
3000	6 inch/H_2O	18 inch/H_2O	40 inch/H_2O
4000	9 inch/H_2O	25 inch/H_2O	50 inch/H_2O
5000	11 inch/H_2O	31 inch/H_2O	63 inch/H_2O

Choosing the Right Pump

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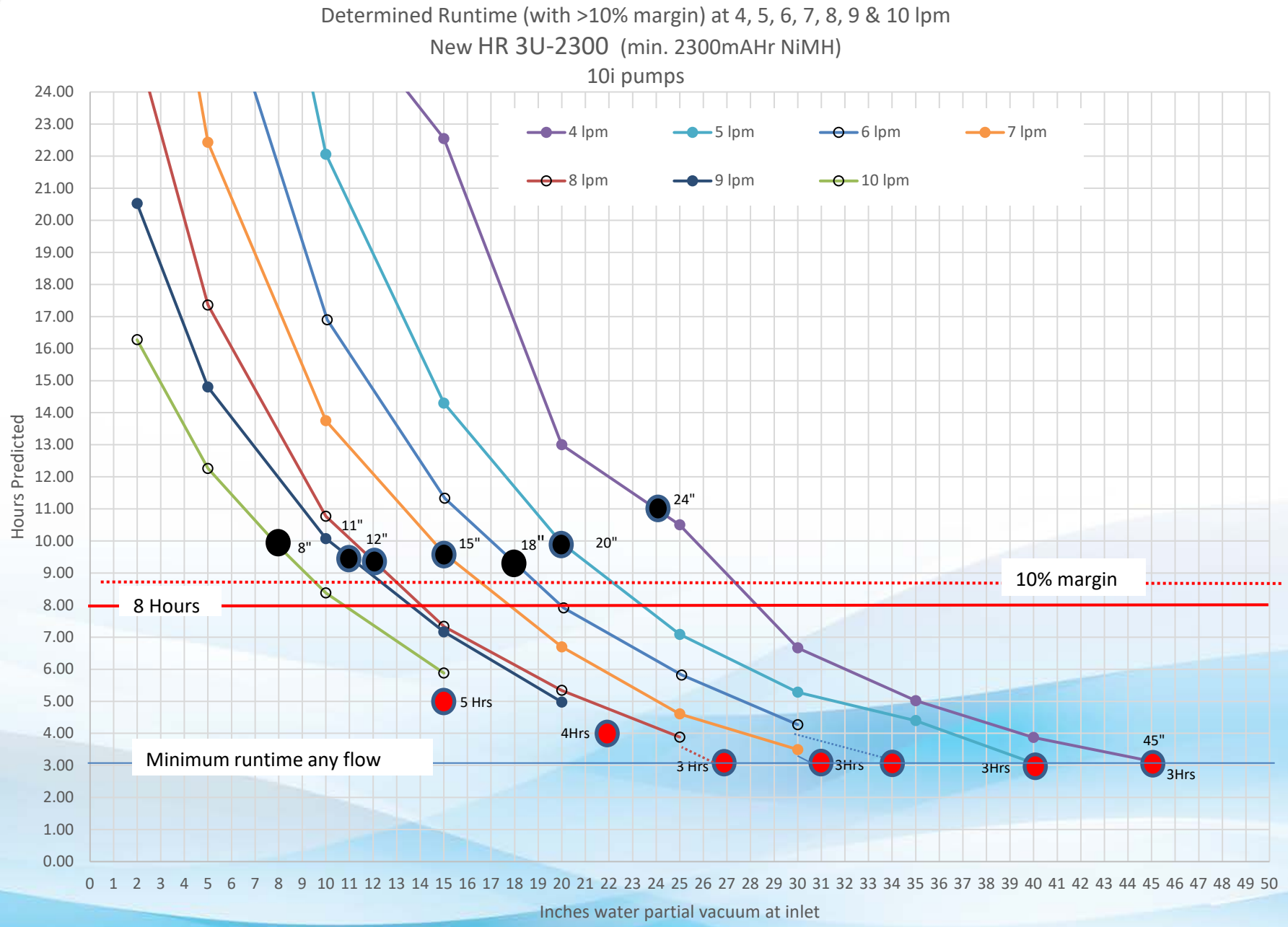
	GilAir Plus		Gilian 5000		Gilian 10i		Gilian 12	
Total Flow Range	1-5,100 cc/min		20-5,000 cc/min		4000 - 10,000 cc/min		4000 - 12,000 cc/min	
High Flow Range, Constant Flow	450-5,100 cc/min 0.45-5.1 LPM		800-5000 cc/min 0.8-5LPM		4000-10,000 cc/min 4-10.0 LPM		4000-12,000 cc/min 4-12.0 LPM	
High Flow Range, Constant Pressure	450-5,100 cc/min to 30" H_2O (7.5 kPa) †††		NA		NA		NA	
Low Flow Range, Constant Flow	20-445 cc/min No module needed		NA		NA		NA	
Low Flow Range, Constant Pressure	1-445 cc/min, @ 40" ± 2.5" H_2O (10.0 ± 0.6 kPa)		20-800 cc/min, @ 15" ± 1.5" H_2O (3.7 ± 0.4 kPa)*		NA		NA	
QuadMode℠ Capable	Yes		No		No		No	
SmartCal℠ Capable	Yes		No		No		No	
Max. Pressure Capability:	Fault †	8 hr. Run††	Fault †	8 hr. Run††	Fault†	8-hr Run††	Fault †	8 hr. Run††
@ 1 LPM, Inches H_2O (kPa)	40 (10.0)	35 (8.7)	70 (17.5)	70 (17.5)	—	—	—	—
@ 2 LPM, Inches H_2O (kPa)	40 (10.0)	30 (7.5)	60 (15.0)	60 (15.0)	—	—	—	—
@ 3 LPM, Inches H_2O (kPa)	35 (8.7)	30 (7.5)	50 (12.5)	50 (12.5)	—	—	—	—
@ 4 LPM, Inches H_2O (kPa)	30 (7.5)	20 (5.0)	30 (7.5)	30 (7.5)	45 (11.3)	24 (6.0)	67 (16.7)	45 (11.3)
@ 5 LPM, Inches H_2O (kPa)	15 (3.7)	12 (3.0)	24 (6.0)	20 (5.0)	40 (10.0)	20 (5.0)	57 (14.2)	38 (9.5)
@ 8 LPM, Inches H_2O (kPa)	—	—	—	—	22 (5.5)	12 (3.0)	33 (8.2)	22 (5.5)
@ 10 LPM, Inches H_2O (kPa)	—	—	—	—	12 (3.0)	8 (2.0)	23 (5.7)	15 (3.0)
@ 12 LPM, Inches H_2O (kPa)	—	—	—	—	—	—	14 (3.5)	10 (2.5)

Battery Drain



Mitigating Risks

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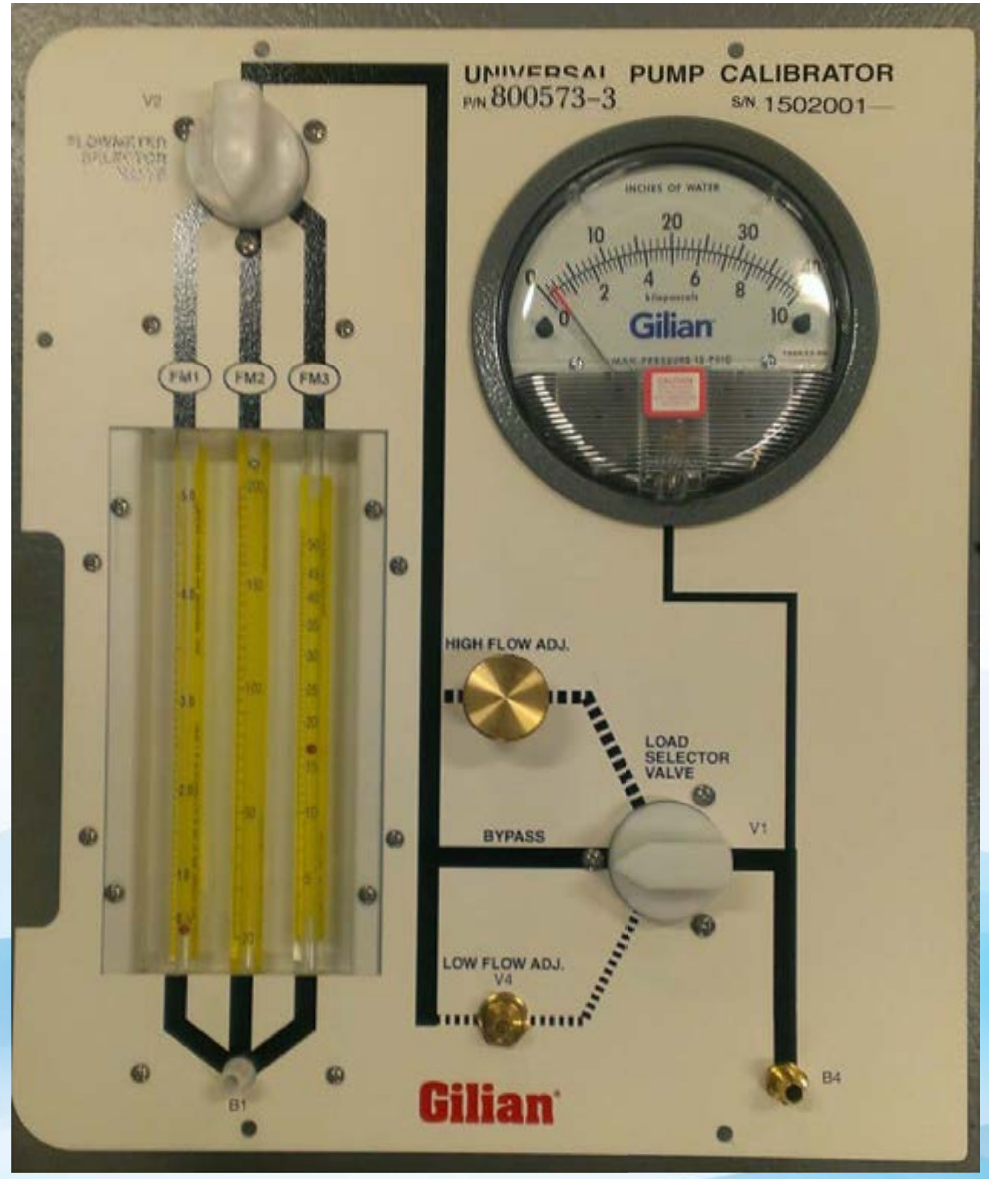
There are numerous ways to mitigate the risks of faults and failures.

- **Know your pumps specifications and thresholds.**
- **Know the environment you are sampling.**
- **Fully charge the battery prior to use.**
- **Check your starting back pressure with media in line.**
- **Periodic checks on BP and Battery during sample event.**
  - **(Use Bluetooth App where available)**
- **Service your pumps regularly!**



Bluetooth and Motion Detection Available in STP and DL Models

- Monitor pump performance during a sample event without disturbing the worker
  - Back Pressure
  - Volume
  - Battery Life
  - Pump Faults
- Start, stop and pause the sample remotely by phone app
- Motion recording assures sample integrity
- Graph live sample data or review previous samples in pump data log
- Check multiple pumps in the same area
- Phone apps available in Apple and Android format

Certified Factory Service

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Why is Factory Service important?

- Ensure continued, maximum performance with annual calibration and service to factory specs
- Sensidyne uses proprietary procedures, software, and tests for both commercial and unpublished specifications, ensuring top performance
- Adjustments, firmware, as well as safety and reliability updates are included with each calibration
- Sensidyne offers flexible service options, allowing you to service your equipment on your own terms

Certified Factory Service

SENSIDYNE®
Industrial Health & Safety Instrumentation

Manufactured to the Highest Quality.
Serviced to the Highest Standards.

Sensidyne's Laboratory is accredited to **ISO/IEC 17025:2017** standards, and Quality Management System (QMS) is certified to **ISO 9001:2015** standards.

Sensidyne has manufactured Gilian precision instruments since 1983, and our Factory Service Department has 100 years of combined expertise servicing Gilian products.

International Organization for Standardization ISO 17025 ACCREDITED LABORATORY

ilac-MRA

A2LA ACCREDITED

CERTIFIED ISO 9001 COMPANY

ISO 9001:2015 CERTIFICATION TM Intertek

ANAB ACCREDITED ISO/IEC 17021 MANAGEMENT SYSTEMS CERTIFICATION BODY

Certified Factory Service

Factory Calibration Includes:

- Disassembly and examination of the instrument for wear and damage
- Full cleaning, repair and/or replacement of parts as needed
- Battery test/replacement as needed
- Upgraded firmware and hardware
- Multi-point flow calibration (customer specific points can be added)
- NIST-traceable calibration certificate with As-Found (optional) and As-Left data
- For Gilibrator Products: **ISO/IEC 17025** accredited calibration with As-Found (optional) and As-Left data
- 180-day service warranty

ISO/IEC 17025 Certificate with Uncertainties for Gilibrator products:

- NIST-traceable calibration
- Test Uncertainty Ratio (TUR) calculation provided
- Includes temperature, relative humidity, and pressure (hPa)

NIST-Traceable Calibration for Go-Cal, Challenger, Nephelometer:

- As-Found (optional) / As-Left data provided
- **ISO 9001:2015** Compliant quality system
- Accreditation includes ANSI/NCSL Z540-1-1994

QUESTIONS?

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THANK YOU

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