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Member of the Exyte Group

Media Supply
5200 East Franklin Road, Suite 100, Nampa ID 83687

Designing for Prevention of Electrostatic Discharge in Process Chemical Applications

Levitronixs® CMP UPC Conference V1 2026

August 2026

World of Exentec

Figures and locations

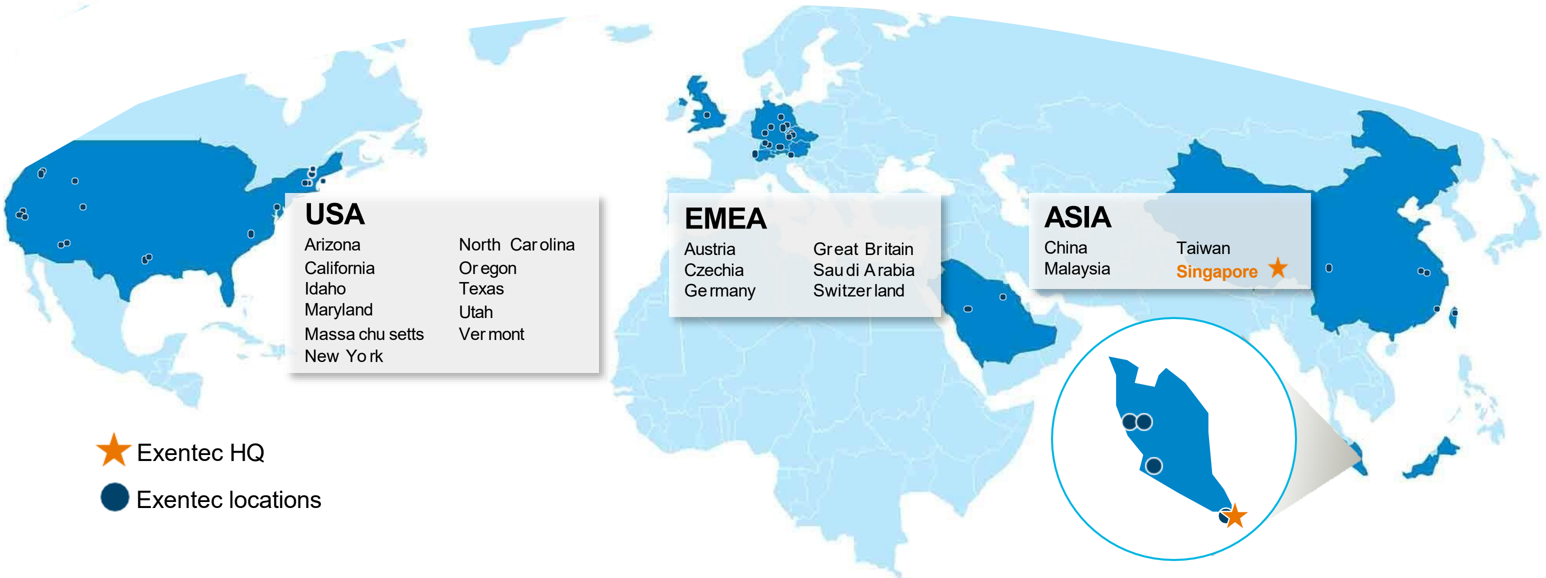
Client base
1000+

Sales bn$
>1.0 (2024)

6000+
Employees (2024)

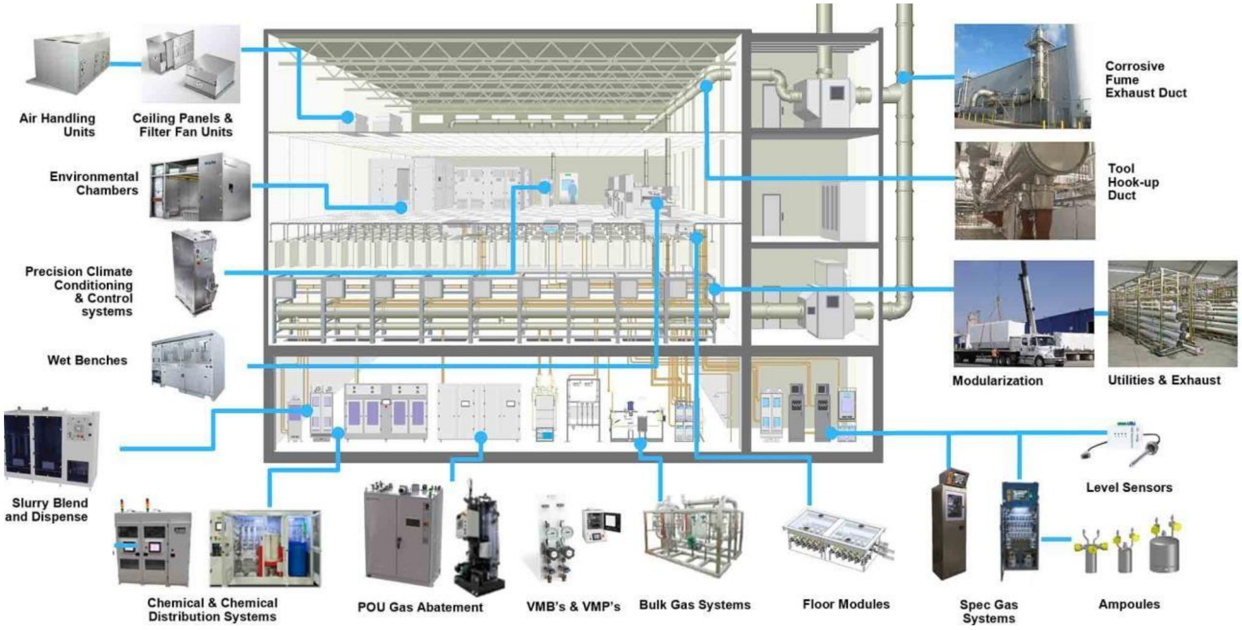
40+
Nationalities

Client-centric operation in
10+
countries



Exentec Products & Services Offerings

Supporting mission-critical semiconductor processes



Category	Fab	Exentec
Process Equipment	✓	
Other (AMHS, etc.)	✓	
Engineering & Architectural	✓	✓
Project Management	✓	✓
Civil, Structural, Architectural (CSA)	✓	
Cleanroom & Dryroom	✓	✓
Mechanical	✓	
Fire & Plumbing	✓	
Mechanical Dry (EXH)	✓	✓
Mechanical Wet	✓	✓
Process Mechanical	✓	✓
Mechanical Installation Services	✓	✓
Mechanical Modular Solutions	✓	✓
Electrical	✓	
Electrical (LV/MV) / Cabling	✓	
Electrical (HV/EHV)	✓	
Extra Low Voltage / LSS	✓	
Instrument. / Autom. & Control	✓	✓
Electrical Installation Services	✓	
Electrical Modular Solutions	✓	✓
Process Utilities	✓	
Gas and Chemicals	✓	✓
(Ultra) Pure Water / Wastewater	✓	
Process Waste	✓	✓
Process Utilities Installation Services	✓	✓
Process Utilities Modular Solutions	✓	✓
Tool Install	✓	✓

The Exentec Organization

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Technology

- **Cleanroom & Dryroom**
  - Cleanroom & Dryroom
  - Controlled Environments
- **Media Supply**
  - Gas Supply
  - Chemical Supply
  - Ampoules & Sensors
  - Slurry Supply Systems
  - Wet Benches
- **Exhaust & Abatement**
  - Exhaust
  - Abatement

Services

- **Installation Services**
  - Installation Services
- **Modular Solutions**
  - Modular Solutions
  - BioPharma Solutions
- **Facility Services**
  - Facility Services

Structured to enable self-performance of OSM and Modular integration across the various product lines

Designing for Prevention of Electrostatic Discharge in Chemical Applications

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Experience That Delivers

Critical Requirements

- *Maintain fluid purity*: prevent contamination of chemical products.
- *Eliminate ESD events*.
- *Ensure product integrity*.

Challenge of Electro-Static-Discharge (ESD) Prevention

- *Contamination risk*: not introduce particulates or impurities.
- *Charge prevention*: not induce electrical charges in chemicals.
- *Material limitations*: not induce ionic impurities.

Solution: Anti Static or Static Dissipative (Anti-Static or SD PTFE / PFA) Plastic Materials

- *In direct contact with the liquid*: provides a safe path for static charge build up and provides adequate dissipation method**.**
- *Eliminates ESD events:* without degrading chemical purity or quality.

The Problem: Contamination vs. Static Charges

- **Higher purity solvents** used in advanced chip manufacturing require no metal ion contamination.
- **Stainless steel piping** add metal ions, so factories are switching to plastics like PFA and PTFE to combat that issue.
- **PFA plastics** stop metal ion contamination but act as electrical insulators.

The Risk: Electrostatic Discharge (ESD)

- **Static charges** build up easily because PFA plastic cannot conduct static electricity as an insulator.
- **Higher purity solvents** moving through these plastic pipes build charges, this charge buildups as it moves along.
- **Sparking (ESD)** can then occur as a result, risking fires, explosions, or equipment damage unless mitigated.


Moving From
This to This


Electro-Static-Discharge design points:

The Material Solution

- Stainless steel cannot be used if it impacts chemical purity with ionic impurities additions.
- Static Dissipative PFA (electrostatic dissipative plastic) then becomes the only alternative to safely conduct away static charges that build.

Chemical Conductivity Classes (NFPA-77)

- Conductive (>10,000 pS/m): Low ESD risk.
- Semi-conductive (10,000 to 50 pS/m): Moderate ESD risk.
- Non-conductive (<50 pS/m): High ESD risk.

The Risk Factors

- All three classes of liquid can still cause dangerous static sparks under certain conditions.
- Two-phase flows (like gas bubbles mixed inside a liquid) accelerate static generation.

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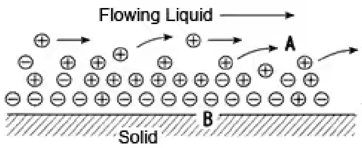
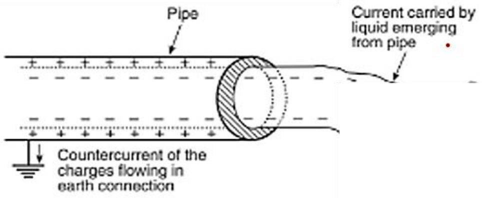
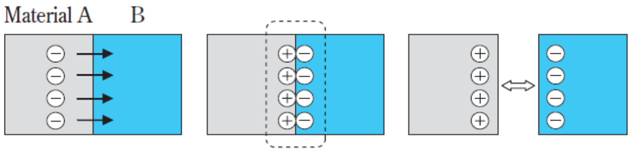




(a) Flow (pipe charging)



(a) Transfer of charge by contact (b) Formation of electric double layer (c) Electrification by separation

How Static Builds Up

- Moving liquid exchanges static charge with the pipe walls as it flows.
- Charge accumulates continuously on the surfaces of system piping, chemical, components over time.
- Large equipment like tanks and pumps multiply the charge because of their larger capacitance.

The Hazard

- Voltages can reach high kilovolts (kV) values inside the chemical conduits, components within the system.
- High voltage causes equipment destruction, part failures, or serious worker injuries when it jumps to grounded location and discharges the static charge potential, like a lightning strike.

The Solution

- Dissipate charges by tapping into negatively charged areas like internal pipe walls or filters.
- Bond these points directly to an external ground outside the fluid pathway.
- Design continuous paths so static electricity potential can safely drain away without stopping.

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For understanding purposes an electrostatic discharge (ESD) event can occur at voltages as low as 0.1 kilovolts (100 volts) 3.5 kilovolts (3,500 volts) for a human to feel the shock.

Air acts as an **insulator**, **breaking down** and **allowing a spark** to jump at roughly **30 kV per-centimeter**.

Electronic circuit pathways are microscopic, gaps between components are tiny. Consequently, it takes a very low voltage (less than 1 kV) to breach those gaps and destroy a systems component like a pressure or flow sensor.

To burn a hole through plastic, an ESD event doesn't need to reach a specific temperature; instead, the microscopic spark plasma instantly reaches temperatures between 1,800° F and 18,000° F (1,000° C to 10,000° C).

- Plastics melt at much lower thresholds between 212° F and 662° F (100° C to 350° C)
- Visible ESD spark is enough temperature to melt / vaporize a localized hole through plastic, tube, pipe or component.

Energy Threshold (Joules), human-body ESD event (around 15 kV) releases a tiny amount of energy, roughly 10 to 30 millijoules (mJ).

- Thin Films ESD hole at 0.01 mJ to 1 mJ
- Thick plastics ESD hole at 1,000+ mJ

Plastic Melting Points, different polymers resist thermal breakdown better than others:

- Low-Resistance Plastics: Polyethylene (PE), Polystyrene (PS), and PVC melt easily between 220° F and 350° F (105° C to 176° C).
- Materials like Teflon (PTFE), PEEK, specialized ESD-safe Polyetherimide (ULTEM) require temperatures from 620° F to over 700° F (327° C to 370° C) to melt

The lightning bolt analogy: when static voltage builds enough to breach air (dielectric breakdown = 30 kV per-centimeter), electrical current constricts to a microscopic channel called a spark filament. The electrical energy is compressed to a cross-section micrometers wide. Energy density acts like a microscopic plasma torch, vaporizing polymer structure precisely where the arc lands. 

A handheld electrostatic field meter works by measuring the electrostatic field strength (Volts per meter) via an internally induced electric charge, which it then converts into a **surface voltage calculation** (Volts or Kilovolts) **based on a fixed distance**.

- Handheld meter to provide an accurate reading, it requires a reference ground.
- Distance-dependent calculation, electric field naturally weakens the further you move away from the source. Therefore, how far away it is from the object matters.
- The 1-inch standard: most handheld meters are factory-calibrated for a specific distance typically exactly 1 inch (2.54 cm) away from the target (near point).
- There are two settings, near and far (6”). Where the far is less accurate and captures a larger field area.

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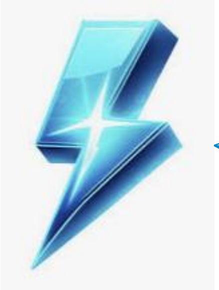
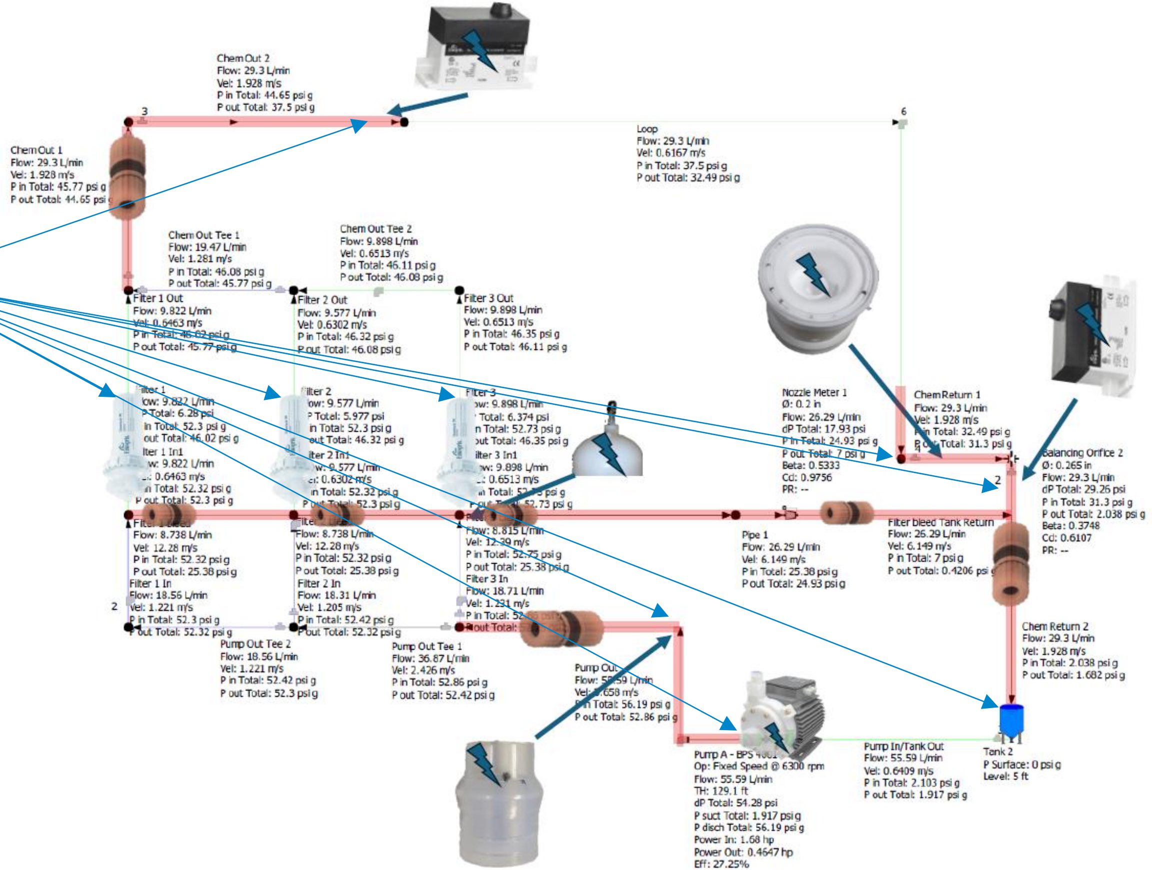
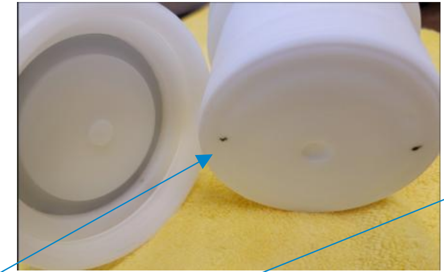
ESD recorded events within operational systems running chemicals such as PGMEA, and IPA… EDS strikes are seen in areas with the highest velocity

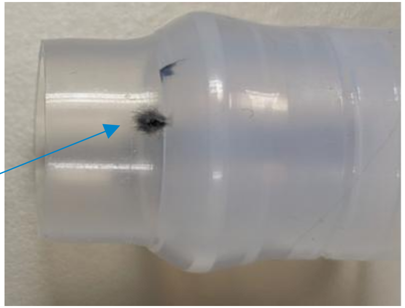


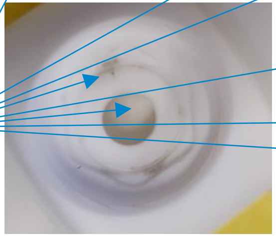


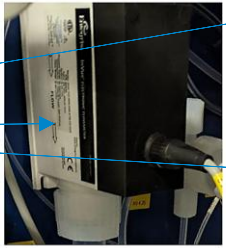
Issues seen at sites

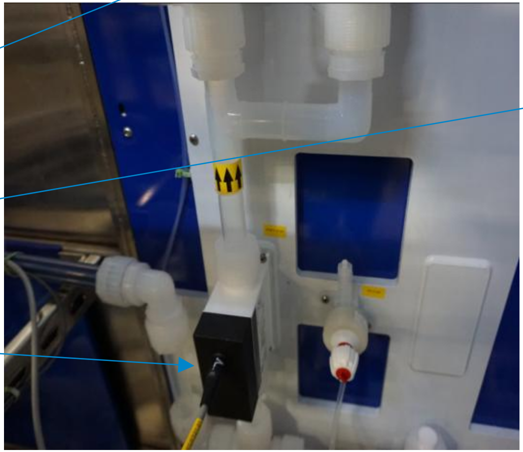
PFA builds ESD Strikes created damage, holes that leaked and started some fires

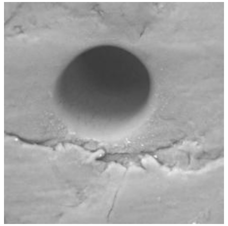












A nanocoulomb meter reads the electrostatic charges in liquid moving through the systems piping.

An electrostatic discharge (ESD) event can occur with charges as low as 0.5 to 1 nanocoulomb (nC), depending on voltage generated.

Charge vs. ESD Thresholds: capacitance determines how much voltage a specific charge will produce ($Q = CV$). Because sensitive electronic components have tiny capacitances, very small amounts of charge can create high, destructive voltages on circuits.

- 0.1 nC to 0.5 nC: generally safe for most components.
- 0.5 nC to 1.0 nC: critical threshold where ESD events begin.
- 5.0 nC to 10.0 nC: generates voltages (often several kilovolts) that will cause a severe ESD event capable of damaging standard component.

Examples for perspective:

- Moving plastic storage container: 10 to 20 nC
- Walking across a carpet: 100 to 200 nC
- Sliding IC chip into plastic carrier: 2 to 5 nC

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Semi / Non-Conductive Challenges:

Standard Practices (BKMs) for Low-Conductivity Chemicals

- **Pipes:** Stainless Steel (SS) is the standard material used to handle low-conductivity fluids safely.
- **Flow:** Keeping pumps at a low or on demand flow, maintaining the lowest acceptable fluid velocities minimizes charge buildup.
- **Purity:** Lowering purity standards and reducing heavy filtration helps reduce static accumulation.

Chemical Comparison

- **PGMEA (30pS/m) vs. IPA (+1,120pS/m 25C):** PGMEA carries a higher static / ESD risk than Isopropyl Alcohol (IPA).
- **Trade-off:** PGMEA has lower risks in other areas, making it acceptable for less strict handling protocols.

TABLE 3: CONDUCTIVITY OF FLUIDS COMMONLY USED IN SEMICONDUCTOR PROCESSES

Gas or Vapor	Conductivity Pico Siemen/Meter (pS/m)
nBA	4300
PGMEA	3×10^4
nMP	2×10^6
Water – DI 18 mega-ohm-cm	5.5×10^6
Acetone	6×10^6
IPA	6×10^6
Cyclohexanone	10.9×10^6
Methanol	4.4×10^7
Ethyl Lactate	1×10^8
Water – Air Distilled	1×10^9

Increasing Conductivity

Testing, Data, Approach Development

Established an active electro-static-discharge (ESD) test stand / with define objectives for its use:

1. Specify fundamental knowledge to achieve measurable results and a space to demonstrate proven designs that prevent ESD events.
   - **How does it occur?**
     - Understand what can be causing this to occur when Low-conductivity fluids (like many solvents) move through the systems pipes, filters, and components, generating static charge through friction, that's resulting in discharge potentials as negatively charged objects transfer excess electrons to more positively charged ones to equalize their charges.
   - **How do you measure it?**
     - Design the test system to include isolated conductive materials placed at key points where static buildup is expected. Measure their electrical potential against a grounded object using an electrostatic field meter & electrostatic voltmeter, which measures the voltage (or joules per coulomb) between the two charged objects. Increase and decrease these measured potentials with the systems control defining baseline and increasing potentials.
   - **How do you neutralize it?**
     - Incorporate electrostatic potential drop zones and components to allow for more continuous dissipative paths that works to maintain a connection between the negative building charges, draining directly to the opposite charge (ground). Objects that are connected to each other by a good conductor having the same electric charge / thereby preventing ESD events. The more available these points are, the better the overall ESD potential decreases.
2. Continue to test various components and configurations for effectiveness / focused on Impact, Design / with direct involvement from component OEMs. *Todays testing focus is on filter housing and filter elements within them.*
3. Determine and maintain exentec's best-known-method *(BKM)* in designs associated to ESD prevention within our equipment with a continuous improvement philosophy.

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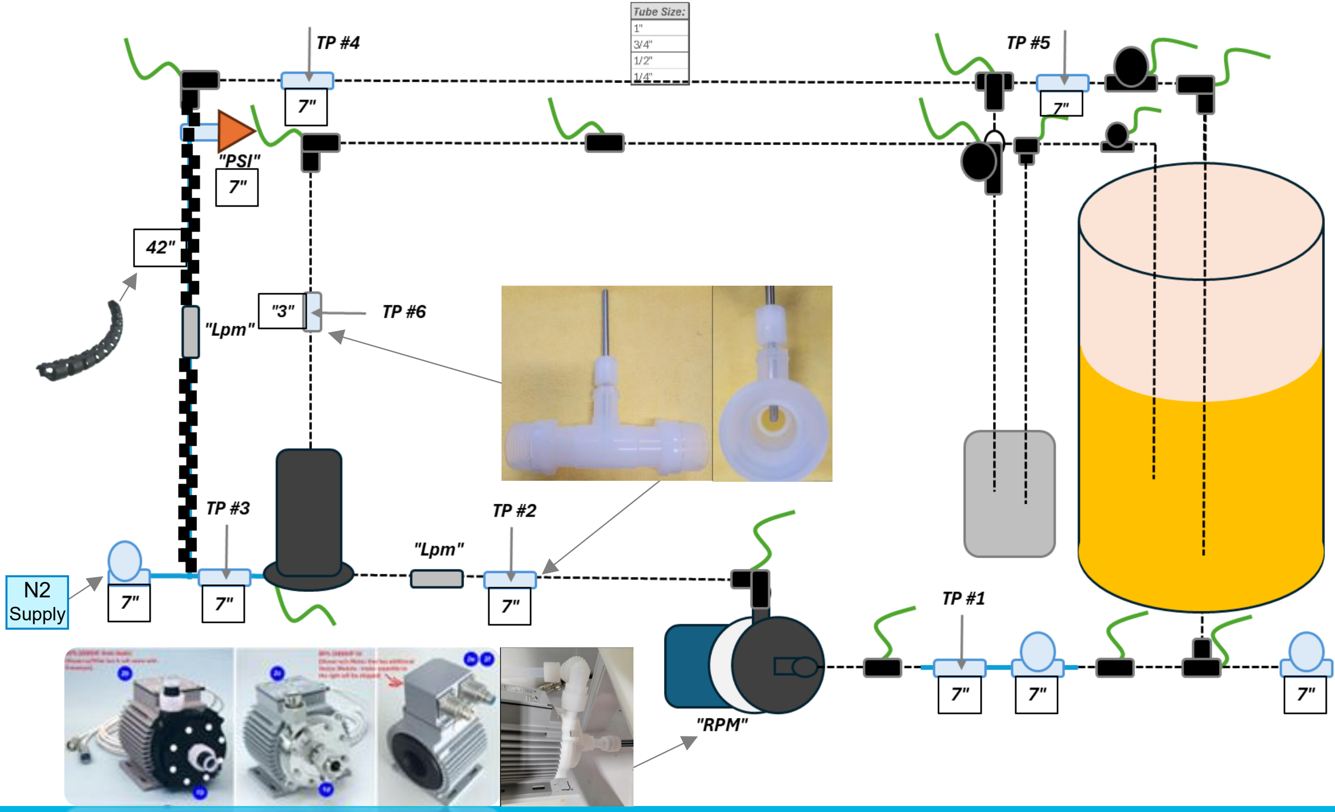
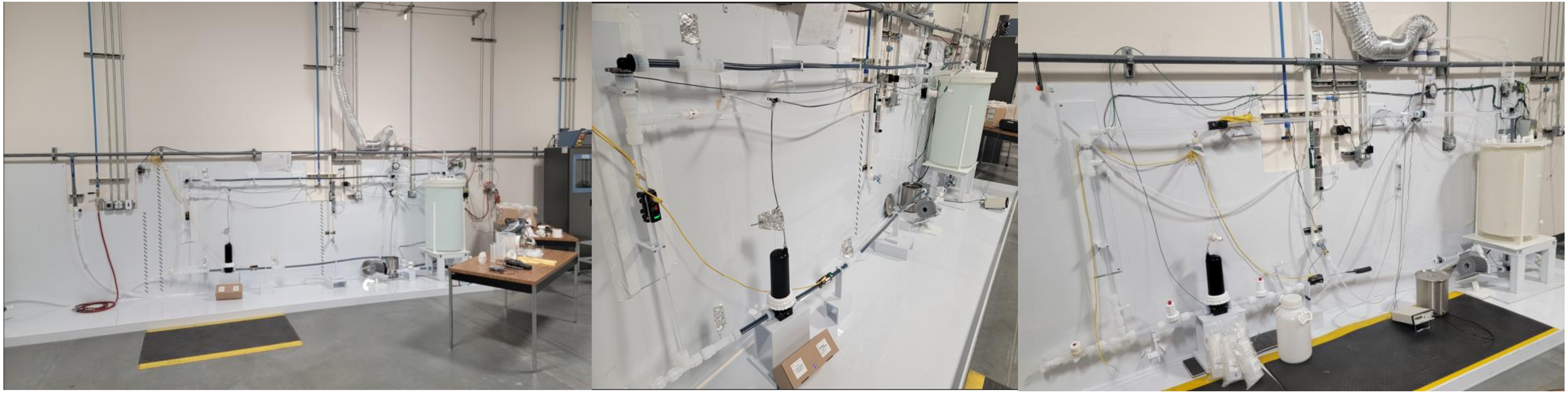
Pilot Test Stand General Layout / components' intended to change for active testing phases

1. Tank 30-gallon, (2-types) HDPE ,PTFE ** plastic lined SS*
2. Pump, (3-types) PTFE, *Anti-Static PTFE*, SS.
3. Hand/Air Valves, (3-types) PFA, PTFE, & Anti-Static or *SDPFA or* ESD prevention
4. Tank Dip-Tubes, (2-types) PFA, & *SDPFA* ESD
5. Union / Adaptor Fittings, (2-types) PFA, & *SDPFA* ESD
6. Tubing, (3-types) PFA, SDPFA ESD wrapped, & *SDPFA* ESD **internal banded*
7. Filter Housing (2-types) PFA, & SDPFA ESD.
8. Test Points (2-Types) for ESD Voltage measured value, at locations shown. Measured in SDPFA material or TP tee with isolated SS rods



Photo’s Pilot Testing Area / Shows Open Architecture

Note: Levitronix static dissipative and stainless-steel pumps were effective in preventing static build up. Therefore, the standard PTFE pump was used in electrostatic potential generation testing.



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Static Dissipative Components

1. *Entegris FluoroLine® Plus ESD tubing* **internal SD-Plastic only*
2. *Entegris PrimeLock® ESD SDPFA fittings*
3. *Entegris Integra® Plus WS ESD SDPFA valves*
4. *Entegris Integra® Plus CRE ESD SDPFA valves*
5. *Entegris Chemlock® ESD SDPFA filter housing*
6. *Nippon Pillar® ESD SDPipe / SDTubing wrap*
7. *Levitronix® PTFE, SDPTFE & SS BPS pumps*
8. *QC systems® AS ESD SDPFA drum dip tube, QC head, & corrugated tube*

Measurement Tools

1. *Keyence® FDH & Sonotec® CO.65-ATEX ultrasonic flowmeter*
2. *HZR® surface resistivity meter*
3. *Fisherbrand® RTD probe thermometer*
4. *Newtry® FMX-003 & Keyence SK-H050 ESD meter*
5. *HT607® relative humidity meter*
6. *Thermo-Scientific® Orion StaraA222 conductivity meter*
7. *ETS® M-230 Meter & Faraday Cup nanocoulomb meter*



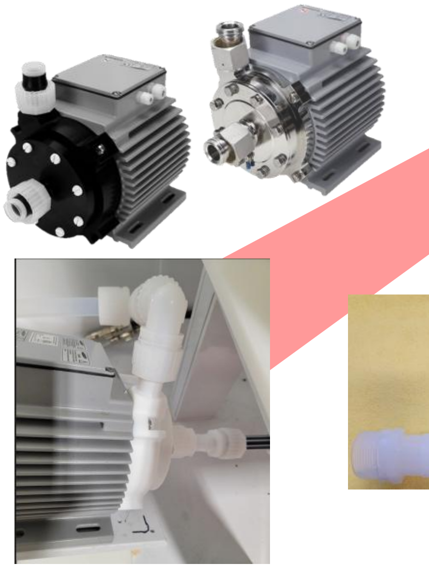


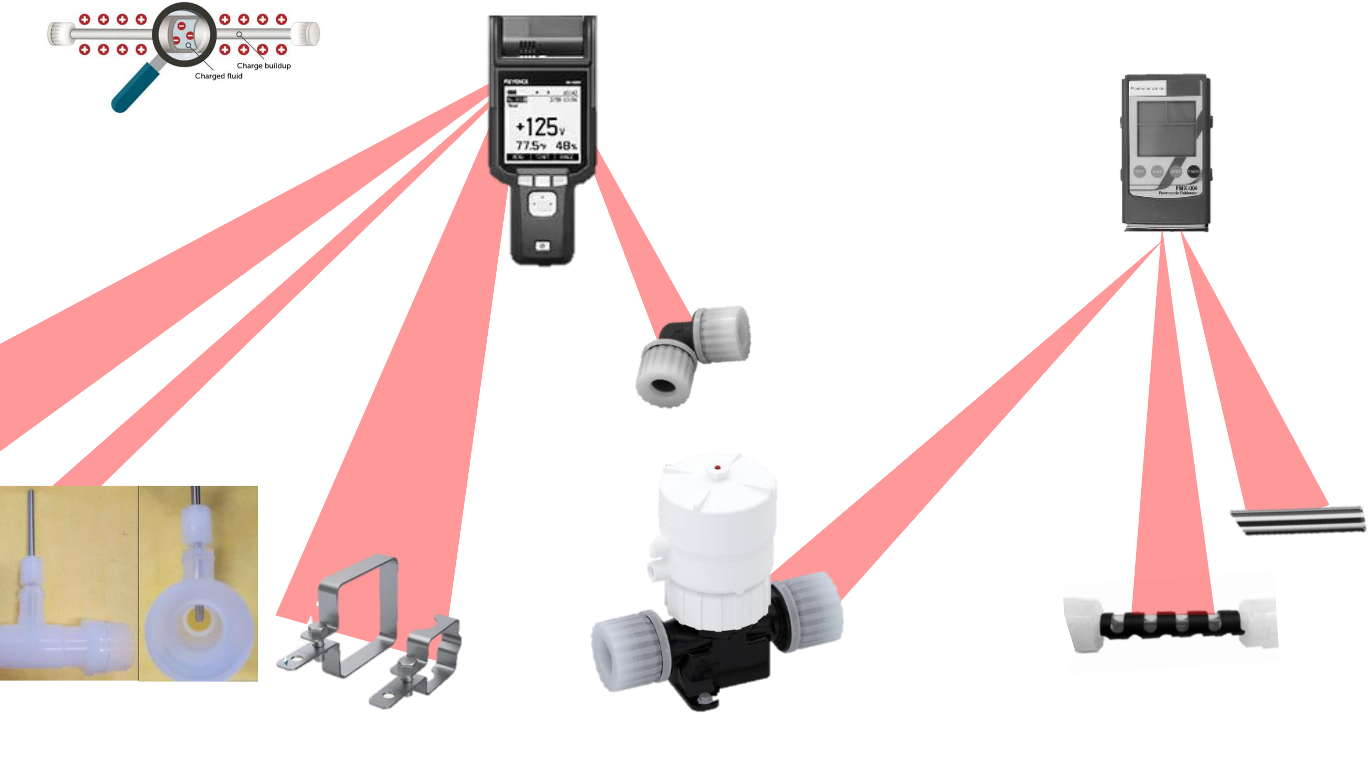




Electro-Static-Discharge design details:

How to measure ESD potential at test points when using different materials.





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Test plan overview:

- ***Test #1***
  - Run standard PFA components system Test Stand loop with no charge potential drain points to establish baseline data.
- ***Test #2***
  - After reviewing data from Test #1, install charge potential drain points (ground paths) at specified locations. *(Antistatic-Tubing & Fittings)*
  - *Run Test Stand to collect new data to evaluate effectiveness and identify any need for additional grounding locations.*
- ***Test #3***
  - Based on Test #2 results, add further charge potential drain points at new locations. *(More Anti static Fittings, Valves, Pumps, & Filters)*
  - Run Test Stand to collect new data to evaluate effectiveness and identify any need for additional grounding locations.
  - *Gather additional data and determine if further testing is necessary.*
- ***Test #4***
  - Based on Test #3 results, add further charge potential drain points at new locations. *(More Antisatic Fittings)*
  - Gather additional data and determine if further testing is necessary.

- ***Test Solution***
  - The test liquid solutions where a mixture of safe to handle non-flammable materials such high-purity water with N_2 micro bubbles entrained or 5% IPA, dichloromethane maintained below 18C, last using white mineral oil for maximum electrostatic potential development.
  - Target conductivity: <50 pS/m (non-conductive range).
  - N_2 blanketing applied to isolate the test solutions from ambient room air.

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Electro-Static- design details:

TEST PARAMETERS

TEST SETUP PARAMETERS									
12 L/min		24 L/min		36 L/min		48 L/min		60 L/min	
PFA	ESD	PFA	ESD	PFA	ESD	PFA	ESD	PFA	ESD
4’	0’	4’	0’	4’	0’	4’	0’	4’	0’
1’	3’	1’	3’	1’	3’	1’	3’	1’	3’
2’	2’	2’	2’	2’	2’	2’	2’	2’	2’
3’	1’	3’	1’	3’	1’	3’	1’	3’	1’
0’	4’	0’	4’	0’	4’	0’	4’	0’	4’

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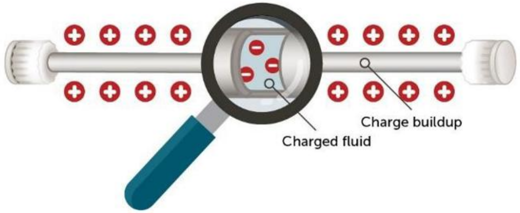
Testing Take aways

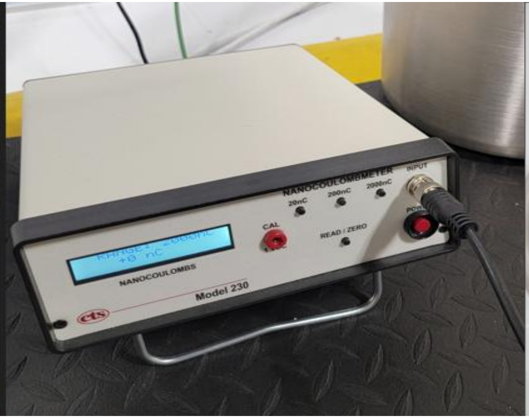


1. **Standard PFA pipe and tubing will build and hold greater than 20KV ESD-strike potential** which is problematic for many zones
2. **¼” - 1” Static-Dissipative components are effective in dissipating measurable <4 up to 20 kV ESD-strike potential when properly grounded.** And the liquid leaving the distribution system has <1 ESD potential charge when measured
3. **Static Dissipative dip-tub in tank proved effective in draining ESD potential away**
4. **Standard PFA, PTFE pump shows to be ESD generation point in low and nonconductive liquid, using grounded Anti-Static or entering, and exiting pump, helps to dissipate the field measured.**

Pilot Testing Photo’s

Designing for Prevention of Electrostatic Discharge in Chemical Applications

Pilot Testing Photo’s



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	Temp C°	Pump RPM	Flow rate Lpm	Press PSI	Voltage Potential kV Bottom of tank	Voltage Potential kV *Tank Outlet HV PFA GEMU*	Voltage Potential kV *Pump Inlet*	Voltage Potential kV *Pump Head*	Voltage Potential kV *Pump Outlet*	Voltage Potential kV *Filter Bowl*	Voltage Potential kV *Post- Filter PFA Tee*	Voltage Potential kV *Filter Outlet post FMT Elbow*	Voltage Potential kV *Tank Return Tee* PROBE	Voltage Potential kV *Tank Return Tee*	Voltage Potential kV *Tank Return Elbow*	Voltage Potential kV *Filter Bleed Elbow*	Voltage Potential kV *Filter Tank Return union*	Voltage Potential kV *Filter Tank return Elbow*
Un-Grounded loop SDPTFE Pump Head	23.3	7000	39.75	9	-0.83	-3.58	-2.29	-4.11	-1.13	-0.60	-1.77	-1.48	-0.82	-0.72	-0.80	-0.55	-0.55	-1.00
Un-Grounded loop *PTFE pump head	24.3	7000	40.0	10	-0.83	-5.52	-3.62	-6.23	-1.42	-0.60	-4.20	-3.11	-1.24	-0.72	-0.80	-0.55	-0.55	-1.00
Grounded loop *PTFE Pump Head	24.8	7000	39.9	9	-0.54	-2.97	-1.62	-6.15	-1.24	-0.57	-2.80	-2.91	-1.20	-0.67	-0.78	-0.43	-0.54	-0.93
Grounded loop *SDPTFE **Pump Head &** SDPTFE **filter**	24	7000	39.75	10	***-0.26***	***-0.21***	***-0.14***	***-0.19***	***-0.17***	***-0.17***	***-0.16***	***-0.13***	***0.05***	***-0.14***	***-0.18***	***-0.18***	***-0.24***	***-0.18***
Grounded loop *PTFE Pump Head & PFA filter	24.6	7000	39.9	9	-0.53	-2.21	-1.65	-6.42	-1.36	-2.35	-3.50	-3.31	-1.22	-0.69	-0.79	-0.49	-0.54	-0.96

Red and Yellow indicate electrostatic potential building toward discharge levels.

Data support the use of Anti Static PFA.

Lowest risk when there is complete continuity in grounding of the equipment's components and instruments.

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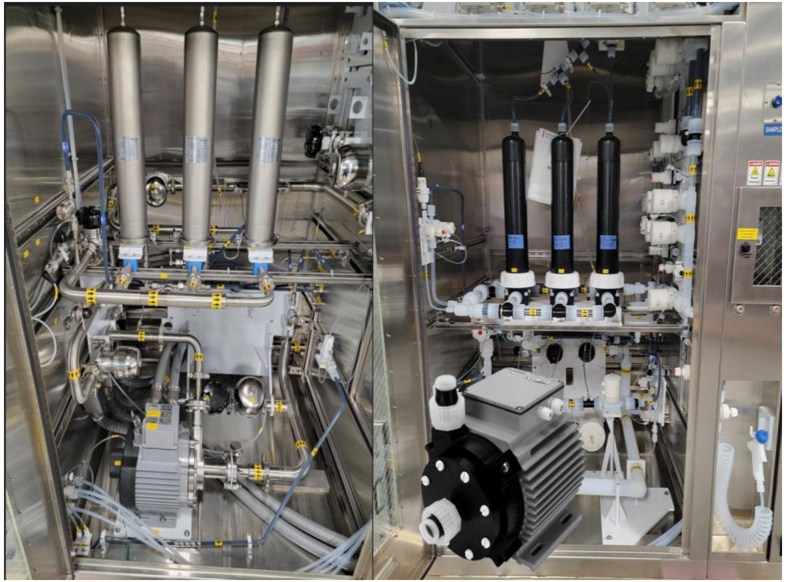
Key benefit enhancements include:

- Improved system reliability
- Lowest risk of ESD-related events
- Continued alignment with purity standards

Anti-Static or Static Dissipative (SDPFA) plastic materials in direct contact with liquid media proved to be effective in accomplishing the prevention of electrostatic discharge in chemical applications!

Data indicates no found risk to purity or quality.



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Levitronix Leach-out Data of anti-static Levitronix Pump Head

Leachout Testing according Semi F57 (7 Days DI at 85°C) - Extraction Elements in [ug/m2]																																
Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Gallium (Ga)	Germanium (Ge)	Iron (Fe)	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Neodymium (Nd)	Nickel (Ni)	Potassium (K)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Vanadium (V)	Zinc (Zn)	Total Metal	Total Oxidizable Carbon (TOC)
1.3	*	*	*	*	*	*	0.9	*	*	0.1	*	*	0.5	*	*	1	*	*	*	*	*	0.6	*	1.2	*	*	*	0.1	*	0.1	6	470

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Recent 3rd party testing shows :

Static Dissipative (SDPFA) Filter Head Housing and other anti-components do not leach M11 elements when exposed to critical chemicals.

Results and Discussion

- Filter Head Extractions – Samples were acidified in 1% nitric acid and analyzed against a new/clean unextracted sample.
- Agilent 8800 QQQ ICPMS
- All elements were below lab detection limits for their respective chemical

Extract Material	Li	Na	Mg	Al	K	Ca	Cr	Fe	Ni	Cu	Zn
Filter 1 - SSTA47	*<352*	*<352*	*<352*	*<352*	*<352*	*<352*	*<352*	*<352*	*<352*	*<352*	*<352*
Filter 2 - Thinner A	*<371*	*<371*	*<371*	*<371*	*<371*	*<371*	*<371*	*<371*	*<371*	*<371*	*<371*

Table 1. Results are in ng/filter. Detection limits were estimated based on extracted sample mass.

Entegris extractable data presentation can provide greater details

Filter Heads in extraction bags
Step = chemical extraction

Questions
Thank You

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