ETS·LINDGREN®
An ESCO Technologies Company

LPRX and LFPRX Series Filters
RFI / EMI
10A - 400A Panel Filters

Installation and Maintenance Manual

December 2019

1706370 Rev B

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NOTES, CAUTIONS, AND WARNINGS

	**Note:** Denotes helpful information intended to provide tips for better use of the product.
CAUTION	**Caution:** Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.
WARNING	**Warning:** Denotes a hazard. Failure to follow instructions could result in **SEVERE** personal injury and/or property damage. Included text gives proper procedures.

SAFETY INFORMATION

	**Refer to Manual:** When product is marked with this symbol, see the instruction manual for additional information. If the instruction manual has been misplaced, download it from www.ets-lindgren.com, or contact ETS-Lindgren Customer Service.
	**High Voltage:** Indicates presence of hazardous voltage. Unsafe practice could result in severe personal injury or death.
	**High Voltage:** Indicates presence of hazardous voltage. Unsafe practice could result in severe personal injury or death.
	**Protective Earth Ground (Safety Ground):** Indicates protective earth terminal. You should provide uninterruptible safety earth ground from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

See the ETS-Lindgren **Product Information Bulletin** for safety, regulatory, and other product marking information.

GENERAL SAFETY CONSIDERATIONS

	Before power is applied to this instrument, ground it properly through the protective conductor of the AC power cable to a power source provided with the protective earth contact. Any interruption of the protective (grounding) conductor, inside or outside the instrument, or disconnection of the protective earth terminal could result in personal injury.
 	Before servicing: contact ETS-Lindgren – servicing (or modifying) the unit by yourself may void your warranty. If you attempt to service the unit by yourself, disconnect all electrical power before starting. There are voltages at many points in the instrument which could, if contacted, cause personal injury. Only trained service personnel should perform adjustments and/or service procedures upon this instrument. Capacitors inside this instrument may still be CHARGED even when instrument is disconnected from its power source.
	Only qualified personnel should operate (or service) this equipment.

INTRODUCTION

ETS-Lindgren Filter Panels are electromagnetically isolated Electromagnetic Interference (EMI) Filter cabinets with EMI isolated filter elements. Filters designated as -TS are equipped with transient protection devices (MOVs). The filter is designed to filter internally and externally generated EMI conducted emissions and arrest high transient currents when equipped with MOVs.

ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren Product Information Bulletin included with your shipment for the following:

- Warranty information
- Safety, regulatory, and other product marking information
- Steps to receive your shipment
- Steps to return a component for service
- ETS-Lindgren calibration service
- ETS-Lindgren contact information

PRECAUTIONS

WARNING

LETHAL VOLTAGES PRESENT. THIS UNIT SHOULD BE INSTALLED AND MAINTAINED BY A QUALIFIED ELECTRICIAN.

AUTOMATIC BLEEDER RESISTORS DISCHARGE THE CAPACITORS TO 50 V FIVE (5) SECONDS AFTER POWER IS REMOVED.

USE A SHORTING STICK (NOT INCLUDED) TO TOUCH ALL EXPOSED METAL SURFACES PRIOR TO TOUCHING THE FILTER.

FILTER COMPONENTS

Filter Elements

The filter panel consists of filter elements and termination points. If the filter is equipped with Transient Protection, there will also be MOVs in the panel.

There are **NO USER SERVICEABLE PARTS** inside the filter elements.

Should a filter element be determined to be defective, contact ETS-Lindgren to order a replacement or to schedule its return or replacement.

Terminations

Input

Only qualified personnel should operate or service this equipment.

The source conductors are brought through an opening made in the field on the dirty side of the filter. The opening should be of sufficient diameter to allow the free passage of conductors according to local and national electrical codes as applicable. The conductors should then be directly terminated to the lugs provided (or equivalent). All conductors must be of the appropriate size to carry the required rated current according to local and national electrical codes.

Output

The output conductors are brought into the clean side of the filter through a conduit penetration (if provided) or a circular opening in the back of the filter panel. The conductors should then be directly terminated to the lugs provided (or equivalent). All conductors must be of the appropriate size to carry the required rated current according to local and national electrical codes.

The output terminals of the filter are EMI isolated from the inputs.

Wiring and grounding should be done in accordance to the wiring schematic provided in the Illustrations section of this manual. All conductors must be of the appropriate size to carry the required rated current according to local and national electrical codes.

Filter Penetrations

All filter penetrations include attached conductive elastomeric gaskets to maintain shielding effectiveness and environmental seal.

MOV Failure and Protective Devices

The prime power circuit breaker upstream from the MOV (if provided) protector should provide overcurrent protection. This minimizes the possibility of undetected loss of transient protection (if provided).

Automatic Discharge

Some signal filters contain bleeder resistors that will automatically reduce the voltage on any component to less than 50 V within five (5) seconds after the removal of input power. Contact ETS-Lindgren for details. Always discharge filters as described in the SHORTING STICK section of this manual.

Shorting Stick (Not Provided)

Only qualified personnel should operate or service this equipment.

A shorting stick (grounding rod) should be used by qualified service personnel to ensure all capacitors and other energy storage elements are discharged and in a safe state. All terminals accessible to service personnel and capable of retaining stored energy in the event of automatic discharge circuit failure are accessible and should be shorted to ground with a shorting stick or equivalent.

ELECTRICAL PERFORMANCE CHARACTERISTICS

Voltage

60 Hz Filters -- Nominal	
Line-to-Ground	0 - 277 VAC
Line-to-Line	0 - 480 VAC

The filter may operate with DC voltages or lower frequencies up to the maximum rated AC voltage.

Operating filters without power correction coils will cause excessive reactive current to flow even with no load present.

CAUTION Do not operate filters at lower than 350 Hz if power correction coils are connected.

Voltage Drop

The total AC voltage drop from input to output is designed to be no more than 2% of the rated voltage when measured into a unity power factor.

Overload Current

The filter can withstand an overload current of 1.4 times the rated current in amperes for a period of fifteen (15) minutes and maintain filtering during this period per MIL-F-15733. The filter can also survive without degradation or damage, a short circuit current according to the table in the SHORT CIRCUIT CURRENT RATING section of this manual.

Short Circuit Current Rating

The Arc Interrupt Current Rating (AIC) or Short Circuit Current Rating (SCCR) for the panels is as in table below:

LPRX / LFPRX Filter Current Model	Filter Amperage	Filter Voltage	AIC / SCCR Rating
10 A	10 A	277 / 480 VAC	10 kA
30 A	30 A	277 / 480 VAC	25 kA
60 A	60 A	277 / 480 VAC	25 kA
100 A	100 A	277 / 480 VAC	50 kA
250 A	250 A	277 / 480 VAC	50 kA
400 A	400 A	277 / 480 VAC	100 kA
600 A	600 A	277 / 480 VAC	125 kA
800 A	800 A	277 / 480 VAC	125 kA
1250 A	1250 A	277 / 480 VAC	150 kA

Power Filter Characteristics

UL listed filters will bare a UL listing label. The filter and filter elements comply with current revisions of MIL-F-15733, UL-1283, and IEC 60939.

Insertion Loss (Stop Band)

100 dB from 14 kHz to 40 GHz tested no load per MIL-STD-220.

100 dB from 14 kHz to 20 MHz when tested full load per MIL-STD-220.

Power Factor Correction

If filter is to be used at 400 Hz, it is recommended that a Power Factor Correction coil is installed in shunt between each phase voltage and ground in order to minimize the flow of reactive current. Once the power correction coil is installed, the operating power frequency range of the filter then becomes 350 Hz to 450 Hz. For operation at other frequencies or DC, the coils must be disconnected. Please call ETS-Lindgren before proceeding.

Current

As specified on filter label. Filter may be operated up to the filter's rated maximum current. This is an RMS rating and is a continuous 100% duty cycle rating. The filter may be operated on DC up to the same rating. If the filter is rated at 60 Hz, it may be operated at 400 Hz only if the current and voltage are de-rated to 50% of nominal 60 Hz operation. Contact ETS-Lindgren for more information.

Frequency of Operation (Pass Band)

The filter is designed to operate in DC voltages up to the rated frequency operation indicated on the label. Typically this will be 60 Hz or 400 Hz. The 400 Hz filters are indicated on the label having a "-4" suffix at the end of the model number. See also POWER FACTOR CORRECTION paragraph above.

ENVIRONMENTAL SPECIFICATIONS

Attribute	Operating	Non-Operating
Temperature	-45° C to + 65° C	-55° C to +85° C
Altitude	Sea Level to 8,000 ft	Sea level to 40,000 ft
Humidity	Relative humidity between 10% and 90% at air temperatures between +25° C and +32° C	Relative humidity between 14% at an air temperature of +71° C and as high as 100% at temperatures from 33° C to +33° C with condensation at all temperatures lower than +30° C

The filter will withstand transportation loads of +/- 5 g vertical and +/- 3 g in both horizontal axes, as packaged for shipment.

INSTALLATION

Uncrate all parts. Check all parts for any shipping damage. Ensure adequate space is available for installing the filter.

Do not discard any packaging material until the unit is installed.

CAUTION

Electrical connection should only be performed by a qualified electrician and in compliance with all applicable regulatory agencies.

Connection to the filter should be made by qualified electricians. Refer to the TERMINATIONS section for further details.

Wiring should be done in accordance to the wiring schematic provided in the ILLUSTRATIONS section of this manual and applicable local and national electrical codes and guidelines.

Installation of the conduit penetration and EMI gasket should be done in accordance with the drawing provided in the ILLUSTRATIONS section of this manual.

If a power correction coil needs to be installed, follow the wiring schematic provided in the ILLUSTRATIONS section of this manual.

Grounding

WARNING **ALL POWER FILTERS MUST BE GROUNDED TO THE BUILDING GROUND FOR SAFETY AND PERFORMANCE REASONS.**

In addition, the following installation conditions must be followed per the current revision of UL1283.

- The insulated grounding conductor must be identical in size, insulation material, and thickness to the grounded and ungrounded circuit supply conductors. It must be green and with or without one or more yellow stripes. The insulated grounding conductor must be installed as part of the circuit that supplies the filter. Refer to Table 250-122 of the National Electrical Code for the appropriate size of the grounding conductor.
- The insulated grounding conductor must be grounded to earth at the service equipment or other acceptable building earth ground, such as the building frame, in the case of a high-rise steel frame structure.
- Any attachment-plug receptacles in the vicinity of the filter must be a grounding type. The grounding conductors serving these receptacles must be connected to earth ground at the service equipment or other acceptable building earth ground, such as the building frame, in the case of a high-rise steel-frame structure.
- Pressure terminal or pressure splicing connectors and soldering lugs used in the installation of the filter must be identified as suitable for the material of the conductors. Conductors of dissimilar metals must not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors unless the device is identified for the purpose and conditions of use.

POWER ON

Prior to applying power to the filter, verify wiring is correct. Use an ohmmeter to verify there are no shorts from any line to ground or neutral.

CAUTION Electrical wiring verification should only be performed by a qualified electrician and in compliance with all applicable regulatory agencies.

In-Rush Current

In-rush current is not a concern with filters as it is not a function of the rated current of the filter. In-rush current will be determined mainly by the load connected after the filters. The filter itself is capable of withstanding high in-rush currents created by the load for several seconds.

Reactive (Leakage) Current

Reactive current is the normal presence of current on the filter lines even when no load is connected. A closer examination reveals that when voltage is applied to the filter, there will be a normal current drain. This normal current drain is usually around 10% to 15% of the rated current of the filter. The presence of this current does not indicate a problem unless it is above the level expected. Contact ETS-Lindgren for specific leakage current for each particular filter model. Filters operating at 400 Hz present a unique reactive current condition. See section on POWER FACTOR CORRECTION and FREQUENCY OF OPERATION.

MAINTENANCE

LETHAL VOLTAGES PRESENT. RISK OF ELECTRIC SHOCK.

AFTER REMOVING POWER FROM THE UNIT, THE AUTOMATIC BLEEDER RESISTORS WILL DISCHARGE THE UNIT TO 50 V IN FIVE (5) SECONDS.

USE A SHORTING STICK (NOT INCLUDED) TO TOUCH ALL METALLIC SURFACES EXPOSED BEFORE TOUCHING THE FILTER.

Only qualified personnel should operate or service this equipment.

Periodically power down the filter and remove the wiring compartment lids to check inside for dirt, debris and corrosion. Oil, dirt, debris and corrosion inside the filter compartments should be removed according to appropriate procedures. User's own procedures for the removal of spills, dirt, debris and corrosion should suffice. Should EMI gasket become torn or unusable, contact ETS-Lindgren to order replacement part E-903-008.

The MOV arrestor (if provided) should be replaced when an MOV test (see Capacitance Measurement and MOV Inspection Procedure section) fails to indicate a working MOV. This test may be scheduled annually or as often as the installation procedures require it.

Once a filter is properly installed it typically does not require maintenance under normal operating conditions. However, if there is an extraordinary event affecting the filters (such as a severe voltage overload or water entering the wiring compartments), then the following procedures should be followed depending on the nature of the event. Follow the INSPECTION AND CLEANING OF WIRING COMPARTMENTS procedure after an event that causes abnormal contamination of filter wiring compartments with liquid or debris. Follow the CAPACITANCE MEASUREMENT AND MOV INSPECTION PROCEDURE following an event that causes abnormal voltage overloads or spikes beyond that which the filters are designed to accommodate.

Frequency of maintenance is at the discretion of the user and may be included in a routine maintenance schedule for the connected equipment. However, filters in clean, industrial environments typically do not require maintenance.

Inspection and Cleaning of Wiring Compartments

1. Remove power from the filter(s).
2. Wait at least sixty (60) seconds, then remove the wiring compartment covers.
3. Short the filter terminals to the filter case using a conductive shorting stick (not included) to ensure that the filter capacitors are fully discharged.
4. Inspect the filter terminals and insulators for contamination and/or damage.
5. If the terminals or insulators are cracked or damaged replacement in the field is not possible. Call ETS-Lindgren for instructions.
6. Clean the terminals and insulators as necessary, and remove any loose debris from the wiring compartments.
7. Re-install the wiring compartment covers. Ensure even compression of the RF gasket around the RF tight wiring compartment. Begin by torquing all of the cover screws to 1 N-m, starting in the center of each flange and working out towards the corners. Then, using the same pattern, torque all screws to 5 N-m.
8. Re-apply power to the filter(s).

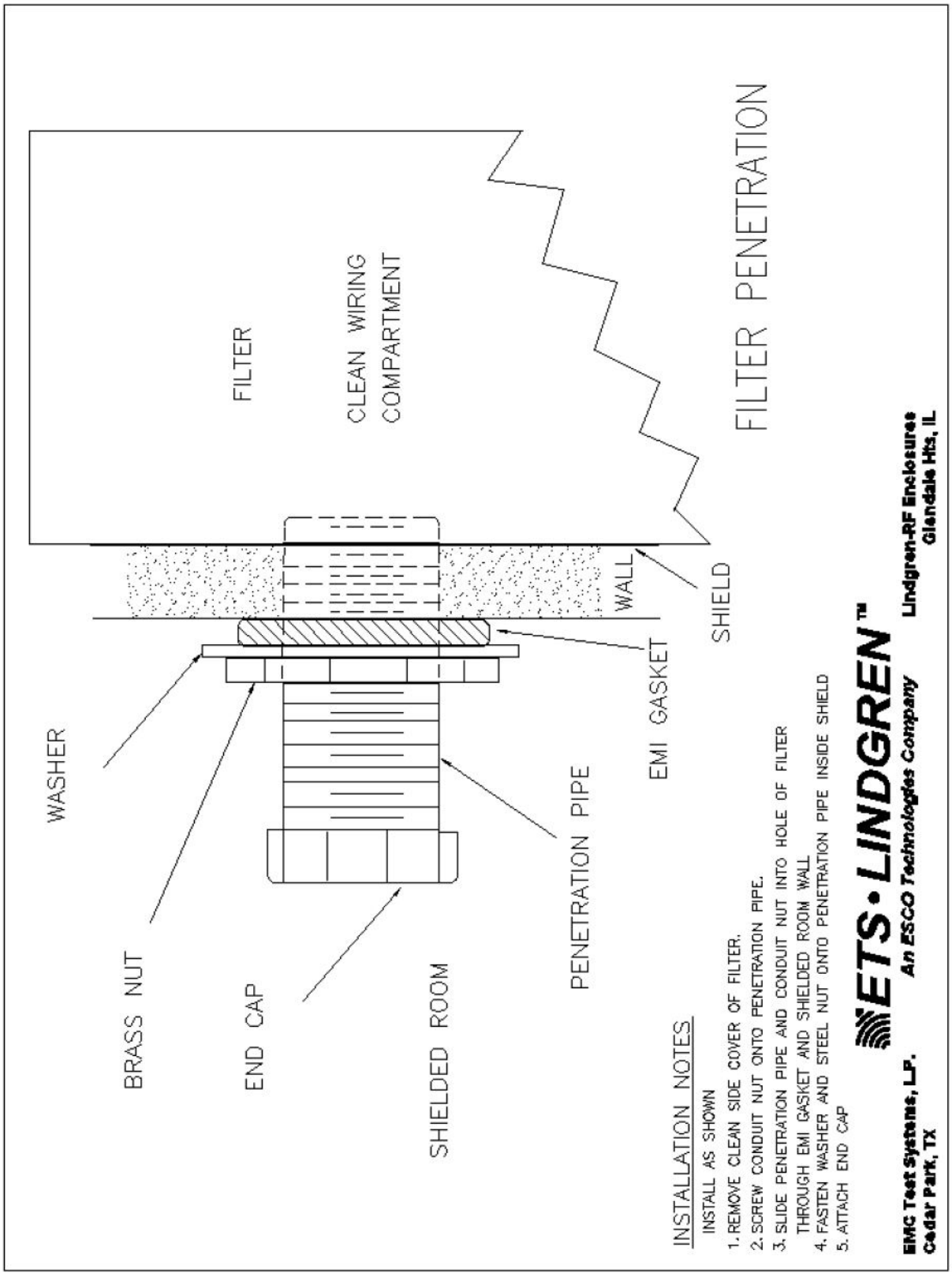
Capacitance Measurement and MOV Inspection Procedure

If no Transient Protection is provided the sections pertaining to MOVs do not apply.

1. Remove power from the filter(s).
2. Wait at least sixty (60) seconds, then remove the wiring compartment covers. Use a voltmeter to ensure no voltage is present.
3. Short the filter terminals to the filter case using a conductive shorting stick (not included) to ensure that filter capacitors are fully discharged.
4. Disconnect the phase and neutral electrical wiring from the electrical termination points.
5. Inspect the filter terminals and insulators for contamination and/or damage.
6. If any of the terminals or insulators are cracked or damaged replace the damaged component in accordance with the directions provided with the replacement parts.
7. Inspect the MOVs (when provided) for damage.
8. If any MOVs are damaged, replace the damaged component in accordance with the directions provided with the replacement parts.
9. Measure MOVs with a Bourns Model 4030-01 (or equivalent) to determine if they are operational. Replacement is required if they are not operational.
10. Measure the line to ground capacitance of each phase. Using an LCR bridge measure the capacitance of each phase at 120 Hz. Contact ETS-Lindgren for expected values (please provide model number of filter). The reading should be according to these values ±20%. A DF measurement should be done at the same time and recorded. DF readings above 0.08 should be noted and ETS-Lindgren should be called for advice before re-applying power to the filter.
11. Clean the terminals and insulators as necessary, and remove any loose debris from the wiring compartments.
12. Re-install the phase and neutral electrical wiring to the electrical termination points. Torque the bolts and/or nuts to the specified torque as noted next to the termination point.
13. Re-install the wiring compartment covers. Ensure even compression of the RF gasket around the RF tight wiring compartment. Begin by torquing all of the cover screws to 1 N-m, starting in the center of each flange and working out towards the corners. Then using the same pattern torque all screws to 5 N-m.
14. Re-apply power to the filter(s).

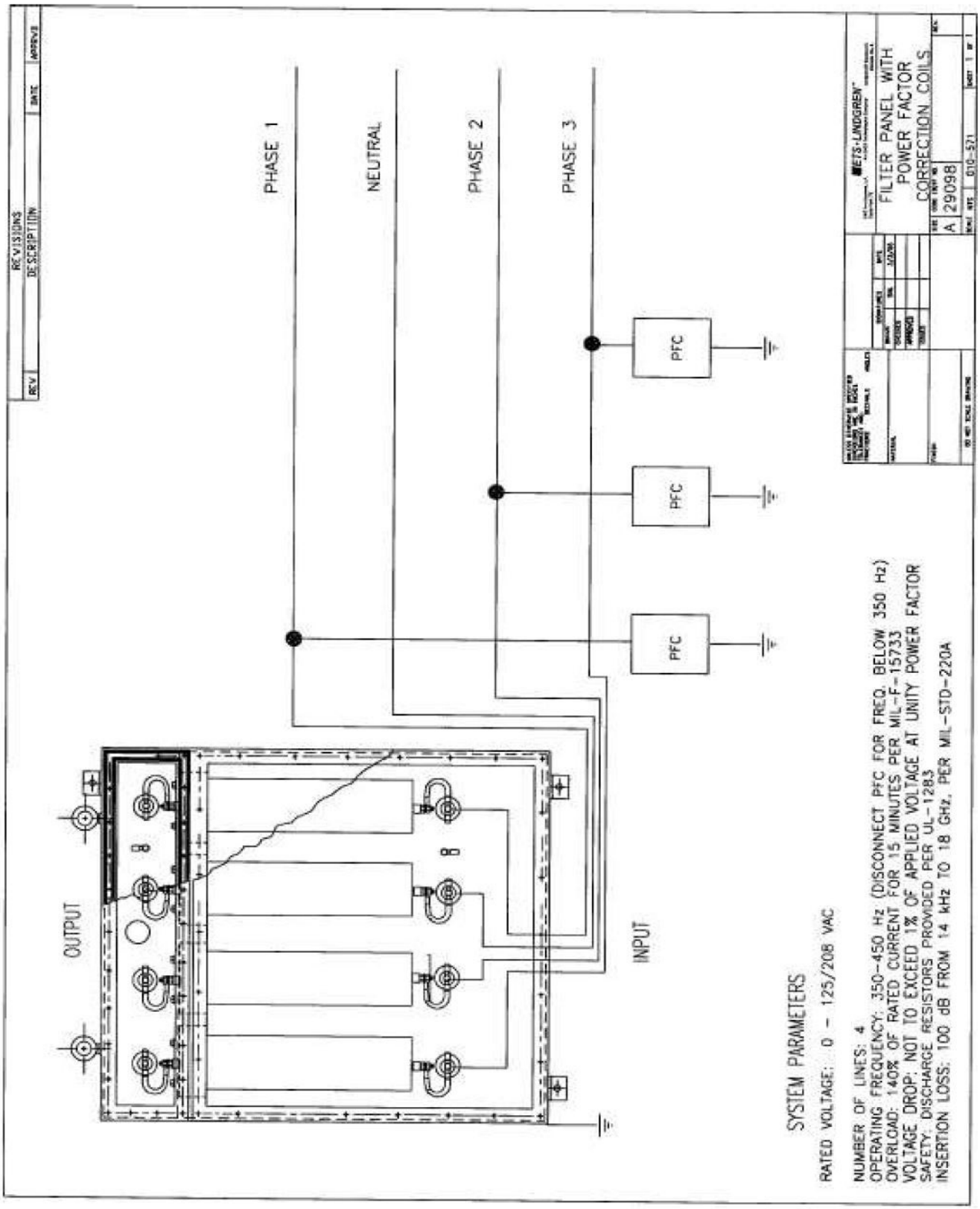
ILLUSTRATIONS

Filter Penetration

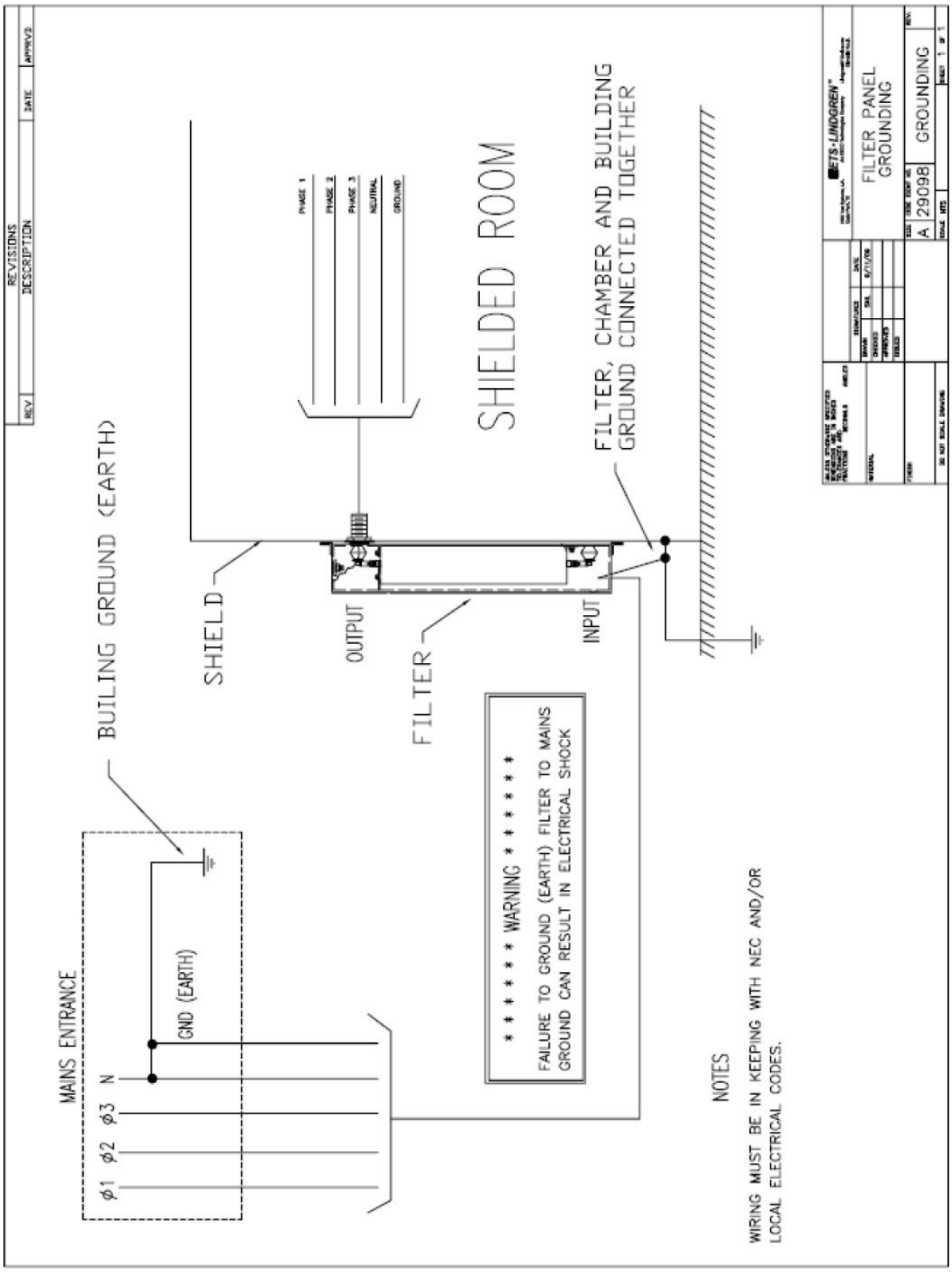


Filter penetrations should be installed as shown

Filter Electrical Wiring



PFCC connections diagram



Proper grounding (earth) and wiring of filter in chamber installation

WARRANTY STATEMENT

ETS-Lindgren Inc., hereinafter referred to as the Seller, warrants that the RF filters purchased under this contract will be free from defects in workmanship performed by the Seller, and will conform to the applicable specifications and/or drawings.

This warranty is limited to either giving credit, repairing or replacing with reasonable promptness after written notice from the buyer of such defect promptly after discovery of same and in no case later than the warranty period after shipment by Seller. The Buyer shall notify the Seller in writing of any defect and include a complete description of the defect within fourteen (14) days after discovery of same to allow the Seller to arrange for appropriate action to make good this warranty, should the Seller determine that the claim is valid.

This warranty does not extend to any portion of the material which has been subject to misuse, neglect, accident, installation or operations not in accordance with the Seller's installation Procedure, nor does it extend to any portion of the material which has been repaired or altered by other than the Seller. The Buyer, upon request shall furnish to the Seller reasonable evidence that the defect arose from causes other than those contained in the preceding sentence.

THIS WARRANTY IS EXCLUSIVE. NO OTHER WARRANTY, WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED BY THIS WARRANTY ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT IS THE SELLER LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

If the Seller is required to take corrective action under the terms of this warranty, it shall be done at no cost to the Buyer. If after proper determination it is found that any claim of defect is indeed the result of causes not covered by this warranty, the Buyer shall pay all costs including reasonable profit to the Seller for expenses incurred during investigation of the Seller of the unwarranted claim.