

PEARL Reconditioning Standards			
MEDIUM VOLTAGE TRANSFORMERS PAD MOUNT OIL-FILLED	Revision		
	Standard	Number	Date
	2420	5	11-2008

The term "reconditioning" is defined as "the process of returning electrical equipment to safe and reliable operating condition based on the design of the original manufacturer at the time of manufacturing."

REFERENCES

The following references are use in this standard. Each of these references can be found in their respective listed locations.

Table References: Section 6000

- Table 1: US Standard bus connection bolt torque values.
- Table 2: Insulation resistance and test values for electrical apparatus.
- Table 5: Overpotential Test Voltages for Non-Inductive Electrical Apparatus
- Table 6: Transformer Insulation Resistance Test Values
- Table 7: Power Factor/Dissipation Factor Recommended Test Voltage Values
- Table 11: Insulation resistance and test temperature conversion to 20°C values.

The Following PEARL Standards are referenced in this standard and should be followed if applicable.

PEARL Standard References

Section 1900: *Apparatus Accessories*

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I TEST EQUIPMENT

The following test equipment is required to perform the testing requirements of this reconditioning standard:

1. Insulation Resistance Test Set (Megohmmeter) 1000 Vdc minimum

One of the following pieces of test equipment is required to perform the turn-to-turn ratio verification testing requirements of this reconditioning standard:

1. Turns-To-Turns Ratio Test Set
2. AC Voltage Supply and Voltmeter (+/- 0.5%)
3. Transformer Winding Resistance Test Set

One of the following pieces of test equipment is required to perform the insulation resistance testing requirements of this reconditioning standard:

1. Power Factor Test Set
2. Dissipation Factor Test Set

One of the following pieces of test equipment is required to perform the overpotential testing requirements of this reconditioning standard if it is required by the customer:

1. AC Overpotential Test Set
2. DC Overpotential Test Set

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II RECONDITION EVALUATION

These steps are used to determine what will be required to recondition this product under this standard.

1 INSPECTION

1.1 Frame/Enclosure

- 1.1.1 Ensure that the nameplate data is legible.
- 1.1.2 Ensure that the third party listing service label is legible.
- 1.1.3 Inspect the overall exterior for missing screws, bolts, nuts, fasteners, retainers and keepers.
- 1.1.4 Inspect for unused openings.
- 1.1.5 Inspect for improper covers.
- 1.1.6 Inspect for rust and corrosion.
- 1.1.7 Inspect for proper alignment of all panels.
- 1.1.8 Inspect for leaks.
- 1.1.9 Verify proper liquid level.
- 1.1.10 Record results on an approved PEARL Evaluation Form.

1.2 Cooling Fans

- 1.2.1 Inspect all control wiring for signs of:
 - 1.2.1.1 Deterioration
 - 1.2.1.2 Overheating
 - 1.2.1.3 Loose connections
- 1.2.2 Check for proper lubrication.
- 1.2.3 Record results on an approved PEARL Evaluation Form.

1.3 Bushings

- 1.3.1 Inspect for signs of overheating.
- 1.3.2 Inspect for signs of deterioration.
- 1.3.3 Inspect for tracking or corona damage.
- 1.3.4 Inspect for chips, cracks, or broken bushings.
- 1.3.5 Record results on an approved PEARL Evaluation Form.

1.4 Surge/Lightning Arrestors

- 1.4.1 Inspect for signs of overheating.
- 1.4.2 Inspect for signs of deterioration.
- 1.4.3 Inspect for tracking or corona damage.
- 1.4.4 Inspect for chips, cracks, or broken insulators.
- 1.4.5 Record results on an approved PEARL Evaluation Form.

1.5 Gauges & Meters

- 1.5.1 Inspect pressure vacuum gauge.
- 1.5.2 Inspect oil temperature gauge.
- 1.5.3 Inspect top oil temperature gauge.
- 1.5.4 Inspect sudden pressure device.
- 1.5.5 Inspect pressure/vacuum control device.
- 1.5.6 Record results on an approved PEARL Evaluation Form.

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1.6 Radiator

1.6.1 Inspect for rust.

1.6.2 Inspect for signs of overheating.

1.6.3 Inspect for leaks.

1.6.4 Record results on an approved PEARL Evaluation Form.

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2 TESTING

2.1 Insulation Resistance

- 2.1.1 Connect all primary terminals together.
- 2.1.2 Connect all secondary terminals together.
- 2.1.3 Primary to secondary and ground test.
 - 2.1.3.1 Perform an insulation resistance test at test voltage specified in Table 6.
 - 2.1.3.2 The test duration shall be for 1 minute.
 - 2.1.3.3 Correct for temperature, if necessary (Table 11).
 - 2.1.3.4 Record results on an approved PEARL Evaluation Form.
 - 2.1.3.5 Compare test results to manufacturer's recommendations or Table 2 of Section 6000.
- 2.1.4 Primary to secondary test
 - 2.1.4.1 Perform an insulation resistance test at test voltage specified in Table 6.
 - 2.1.4.2 The test duration shall be for 1 minute.
 - 2.1.4.3 Correct for temperature, if necessary (Table 11).
 - 2.1.4.4 Record results on an approved PEARL Evaluation Form.
 - 2.1.4.5 Compare test results to manufacturer's recommendations or Table 2 of Section 6000.
- 2.1.5 Secondary to primary and ground test
 - 2.1.5.1 Perform an insulation resistance test at test voltage specified in Table 6.
 - 2.1.5.2 The test duration shall be for 1 minute.
 - 2.1.5.3 Correct for temperature, if necessary (Table 11).
 - 2.1.5.4 Record results on an approved PEARL Evaluation Form.
 - 2.1.5.5 Compare test results to manufacturer's recommendations or Table 2 of Section 6000.

2.2 Transformer Turns Ratio Verification

- 2.2.1 Perform a 'turns ratio' test on each phase from primary to secondary on all taps.
- 2.2.2 Record results on an approved PEARL Evaluation Form.
- 2.2.3 Compare results to manufacturer's recommendations or industrial standards.

2.3 Core Ground

- 2.3.1 Perform a core ground test.
- 2.3.2 Record results on an approved PEARL Evaluation Form.
- 2.3.3 Compare results to manufacturer's recommendations or industrial standards.

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- 2.4 Power Factor or Dissipation Factor**
 - 2.4.1** Connect all primary terminals together.
 - 2.4.2** Connect all secondary terminals together.
 - 2.4.3** Primary to secondary and ground test (“GROUND” mode).
 - 2.4.3.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL} and C_{HG}
 - 2.4.3.2** Correct for temperature. Refer to test set manufacturer’s literature.
 - 2.4.3.3** Record results on an approved PEARL Evaluation Form.
 - 2.4.4** Primary to secondary and ground test (“GUARD” mode)
 - 2.4.4.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HG}
 - 2.4.4.2** Correct for temperature. Refer to test set manufacturer’s literature.
 - 2.4.4.3** Record results on an approved PEARL Evaluation Form.
 - 2.4.5** Primary to secondary and ground test (“UST” mode)
 - 2.4.5.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL}
 - 2.4.5.2** Correct for temperature. Refer to test set manufacturer’s literature.
 - 2.4.5.3** Record results on an approved PEARL Evaluation Form.
 - 2.4.6** Secondary to primary and ground test (“GROUND” mode)
 - 2.4.6.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL} and C_{LG}
 - 2.4.6.2** Correct for temperature. Refer to test set manufacturer’s literature.
 - 2.4.6.3** Record results on an approved PEARL Evaluation Form.
 - 2.4.7** Secondary to primary and ground test (“GUARD” mode)
 - 2.4.7.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{LG}
 - 2.4.7.2** Correct for temperature. Refer to test set manufacturer’s literature.
 - 2.4.7.3** Record results on an approved PEARL Evaluation Form.
 - 2.4.8** Secondary to primary and ground test (“UST” mode)
 - 2.4.8.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL}
 - 2.4.8.2** Correct for temperature. Refer to test set manufacturer’s literature.
 - 2.4.8.3** Record results on an approved PEARL Evaluation Form.
 - 2.4.9** Compare results to manufacturer's recommendations or industrial standards.

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- 2.5 Core Excitation**
 - 2.5.1** Perform a core excitation test on each phase.
 - 2.5.2** Record results on an approved PEARL Evaluation Form.
 - 2.5.3** Compare results to manufacturer's recommendations or industrial standards.
- 2.6 Oil Testing (An oil sample may be sent to a lab to complete this section.)**
 - 2.6.1 Visual Condition**
 - 2.6.1.1** Perform a visual condition test in accordance with ASTM D-1524.
 - 2.6.1.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.1.3** Compare results to industrial standards.
 - 2.6.2 Color**
 - 2.6.2.1** Perform a color test in accordance with ASTM D-1500.
 - 2.6.2.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.2.3** Compare results to industrial standards.
 - 2.6.3 Dielectric Breakdown**
 - 2.6.3.1** Perform a dielectric breakdown test in accordance with ASTM D-877 or ASTM D-1816.
 - 2.6.3.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.3.3** Compare results to industrial standards.
 - 2.6.4 Neutralization Number**
 - 2.6.4.1** Perform a neutralization Number test in accordance with ASTM D-974.
 - 2.6.4.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.4.3** Compare results to industrial standards.
 - 2.6.5 Interfacial Tension**
 - 2.6.5.1** Perform a neutralization number test in accordance with ASTM D-971 or D-2285.
 - 2.6.5.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.5.3** Compare results to industrial standards.
 - 2.6.6 Power/Dissipation Factor**
 - 2.6.6.1** Perform a power/dissipation factor test in accordance with ASTM D-924 @ 25C.
 - 2.6.6.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.6.3** Compare results to industrial standards.
 - 2.6.7 Water Content**
 - 2.6.7.1** Perform a water content test in accordance with ASTM D-1533.
 - 2.6.7.2** Record results on an approved PEARL Evaluation Form.
 - 2.6.7.3** Compare results to industrial standards.

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2.6.8 Dissolved Gas Analysis

- 2.6.8.1** Perform a dissolved gas analysis in accordance with ANSI/IEEE C57.104 or ASTM D-3612.
- 2.6.8.2** Record results on an approved PEARL Evaluation Form.
- 2.6.8.3** Compare results to industrial standards.

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III RECONDITIONING PROCEDURES

The following procedures are in a recommended order and are required to recondition this product. PEARL recognizes that, based on actual product design and as found condition, some of these procedures may not be applicable. The testing requirement must be completed before the product can be labeled as a PEARL reconditioned product.

1 RECONDITIONING

1.1 Frame/Enclosure

- 1.1.1 Disassemble to clean.
- 1.1.2 Cover or remove all high and low side bushing.
- 1.1.3 Cover or remove all gauges.
- 1.1.4 Cover or remove all nameplates.
- 1.1.5 Clean all parts of contamination and corrosion.
- 1.1.6 Prepare the frame/enclosure to paint, as necessary.
- 1.1.7 Paint frame/enclosure.

1.2 Bushings

- 1.2.1 Clean all bushings of contamination and corrosion.
- 1.2.2 Verify the integrity of all bushings.

1.3 Oil

- 1.3.1 Oil will be reconditioned or reclaimed based on the oil test result during the inspection section.

1.4 Missing or Defective Components, Parts and Hardware

- 1.4.1 Replace or repair any missing or defective components, parts and hardware found during the inspection phase of this standard.

1.5 Surge Arrestors

- 1.5.1 Surge arrestors will be reconditioned in accordance with applicable PEARL Reconditioning Standards found in Section 1900.

1.6 Lubrication

- 1.6.1 Lubricate hinges.

1.7 Torque

- 1.7.1 Check all screw and bolt connections for the proper torque per manufacturer's recommendations or industrial standards (Table 1).
- 1.7.2 Record results on an approved PEARL Reconditioning Test Form.

1.8 Final Assembly

- 1.8.1 Ensure that frame is plumb and square.
- 1.8.2 Cover any unused openings.
- 1.8.3 Ensure that the nameplate/label data is complete, correct and legible.

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2 TESTING

2.1 Insulation Resistance

- 2.1.1 Connect all primary terminals together.
- 2.1.2 Connect all secondary terminals together.
- 2.1.3 Primary to secondary and ground test.
 - 2.1.3.1 Perform an insulation resistance test at test voltage specified in Table 6.
 - 2.1.3.2 The test duration shall be for 1 minute.
 - 2.1.3.3 Correct for temperature, if necessary (Table 11).
 - 2.1.3.4 Record results on an approved PEARL Reconditioning Form.
 - 2.1.3.5 Compare test results to manufacturer's recommendations or Table 2 of Section 6000.
 - 2.1.3.6 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.1.4 Primary to secondary test
 - 2.1.4.1 Perform an insulation resistance test at test voltage specified in Table 6.
 - 2.1.4.2 The test duration shall be for 1 minute.
 - 2.1.4.3 Correct for temperature, if necessary (Table 11).
 - 2.1.4.4 Record results on an approved PEARL Reconditioning Form.
 - 2.1.4.5 Compare test results to manufacturer's recommendations or Table 2 of Section 6000.
 - 2.1.4.6 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.1.5 Secondary to primary and ground test
 - 2.1.5.1 Perform an insulation resistance test at test voltage specified in Table 6.
 - 2.1.5.2 The test duration shall be for 1 minute.
 - 2.1.5.3 Correct for temperature, if necessary (Table 11).
 - 2.1.5.4 Record results on an approved PEARL Reconditioning Form.
 - 2.1.5.5 Compare test results to manufacturer's recommendations or Table 2 of Section 6000.
 - 2.1.5.6 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.2 Transformer Turns Ratio Verification

- 2.2.1 Perform a 'turns ratio' test on each phase from primary to secondary on all taps.
- 2.2.2 Record results on an approved PEARL Reconditioning Test Form.
- 2.2.3 Compare results to manufacturer's recommendations or industrial standards.
- 2.2.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.3 Core Ground

- 2.3.1 Perform a core ground test.
- 2.3.2 Record results on an approved PEARL Reconditioning Test Form.

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- 2.3.3 Compare results to manufacturer's recommendations or industrial standards.
- 2.3.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.4 **Power Factor or Dissipation Factor**
 - 2.4.1 Connect all primary terminals together.
 - 2.4.2 Connect all secondary terminals together.
 - 2.4.3 Primary to secondary and ground test ("GROUND" mode)
 - 2.4.3.1 Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL} and C_{HG}
 - 2.4.3.2 Correct for temperature. Refer to test set manufacturer's literature.
 - 2.4.3.3 Record results on an approved PEARL Reconditioning Test Form.
 - 2.4.4 Primary to secondary and ground test ("GUARD" mode)
 - 2.4.4.1 Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HG}
 - 2.4.4.2 Correct for temperature. Refer to test set manufacturer's literature.
 - 2.4.4.3 Record results on an approved PEARL Reconditioning Test Form.
 - 2.4.5 Primary to secondary and ground test ("UST" mode)
 - 2.4.5.1 Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL}
 - 2.4.5.2 Correct for temperature. Refer to test set manufacturer's literature.
 - 2.4.5.3 Record results on an approved PEARL Reconditioning Test Form.
 - 2.4.6 Secondary to primary and ground test ("GROUND" mode)
 - 2.4.6.1 Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL} and C_{LG}
 - 2.4.6.2 Correct for temperature. Refer to test set manufacturer's literature.
 - 2.4.6.3 Record results on an approved PEARL Reconditioning Test Form.
 - 2.4.7 Secondary to primary and ground test ("GUARD" mode)
 - 2.4.7.1 Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{LG}
 - 2.4.7.2 Correct for temperature. Refer to test set manufacturer's literature.
 - 2.4.7.3 Record results on an approved PEARL Reconditioning Test Form.
 - 2.4.8 Secondary to primary and ground test ("UST" mode)
 - 2.4.8.1 Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL}

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- 2.4.8.2 Correct for temperature. Refer to test set manufacturer's literature.
- 2.4.8.3 Record results on an approved PEARL Reconditioning Test Form.
- 2.4.9 Compare results to manufacturer's recommendations or industrial standards.
- 2.4.10 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.5 **Core Excitation**
 - 2.5.1 Perform a core excitation test on each phase.
 - 2.5.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.5.3 Compare results to manufacturer's recommendations or industrial standards.
 - 2.5.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.6 **Oil Testing (An oil sample may be sent to a lab to complete this section.)**
 - 2.6.1 **Visual Condition**
 - 2.6.1.1 Perform a visual condition test in accordance with ASTM D-1524.
 - 2.6.1.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.6.1.3 Compare results to industrial standards.
 - 2.6.1.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
 - 2.6.2 **Color**
 - 2.6.2.1 Perform a color test in accordance with ASTM D-1500.
 - 2.6.2.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.6.2.3 Compare results to industrial standards.
 - 2.6.2.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
 - 2.6.3 **Dielectric Breakdown**
 - 2.6.3.1 Perform a dielectric breakdown test in accordance with ASTM D-877 or ASTM D-1816.
 - 2.6.3.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.6.3.3 Compare results to industrial standards.
 - 2.6.3.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
 - 2.6.4 **Neutralization Number**
 - 2.6.4.1 Perform a neutralization Number test in accordance with ASTM D-974.

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2.6.4.2 Record results on an approved PEARL Reconditioning Test Form.

2.6.4.3 Compare results to industrial standards.

2.6.4.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.6.5 Interfacial Tension

2.6.5.1 Perform a neutralization number test in accordance with ASTM D-971 or D-2285.

2.6.5.2 Record results on an approved PEARL Reconditioning Test Form.

2.6.5.3 Compare results to industrial standards.

2.6.5.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.6.6 Power/Dissipation Factor

2.6.6.1 Perform a power/dissipation factor test in accordance with ASTM D-924 @ 25C.

2.6.6.2 Record results on an approved PEARL Reconditioning Test Form.

2.6.6.3 Compare results to industrial standards. The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.6.7 Water Content

2.6.7.1 Perform a water content test in accordance with ASTM D-1533.

2.6.7.2 Record results on an approved PEARL Reconditioning Test Form.

2.6.7.3 Compare results to industrial standards. The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.6.8 Dissolved Gas Analysis

2.6.8.1 Perform a dissolved gas analysis in accordance with ANSI/IEEE C57.104 or ASTM D-3612.

2.6.8.2 Record results on an approved PEARL Reconditioning Test Form.

2.6.8.3 Compare results to industrial standards.

2.6.8.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

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The DC overpotential test of liquid-filled transformers is not recommended. However, if the customer requires that a DC overpotential test be performed, then the values given in Table 5 should be used.

2.7 Overpotential Test

- 2.7.1 Connect all primary terminals together.
- 2.7.2 Connect all secondary terminals together.
- 2.7.3 Primary to secondary and ground test
 - 2.7.3.1 Perform an overpotential test at test voltage specified in Table 5. The test duration shall be for 1 minute once maximum test voltage is achieved.
 - 2.7.3.2 Record results on an approved PEARL Reconditioning Test Form.
- 2.7.4 Primary to secondary test
 - 2.7.4.1 Perform an overpotential test at test voltage specified in Table 5. The test duration shall be for 1 minute once maximum test voltage is achieved.
 - 2.7.4.2 Record results on an approved PEARL Reconditioning Test Form.
- 2.7.5 Secondary to primary and ground test
 - 2.7.5.1 Perform an overpotential test at test voltage specified in Table 5. The test duration shall be for 1 minute once maximum test voltage is achieved.
 - 2.7.5.2 Record results on an approved PEARL Reconditioning Test Form.
- 2.7.6 Record results on appropriate PEARL Inspection and Test Form.
- 2.7.7 Compare results to manufacturer's recommendations or industrial standards.
- 2.7.8 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.8 DC Winding Resistance

- 2.8.1 Perform a DC winding resistance test on each phase on all taps.
- 2.8.2 Record results on an approved PEARL Reconditioning Form.
- 2.8.3 Compare results to manufacturer's recommendations or industrial standards.
- 2.8.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.

2.9 Surge Arrestors

- 2.9.1 Surge arrestors will be tested in accordance with applicable PEARL Reconditioning Standards found in Section 1900.

IV PEARL CERTIFICATION

This product has now been reconditioned under the PEARL Reconditioning Standard. The blue PEARL Reconditioning Quality Seal may now be placed on the device.