

PEARL Reconditioning Standards			
MEDIUM VOLTAGE TRANSFORMERS DRY TYPE	Revision		
	Standard	Number	Date
	2410	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 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 1200: *Molded Circuit Breakers*
- Section 1400: *Low Voltage Transformers*
- 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** Record results on an approved PEARL Evaluation Form.

1.2 Bus Support

- 1.2.1** Inspect for signs of overheating.
- 1.2.2** Inspect for signs of deterioration.
- 1.2.3** Inspect for tracking and corona damage.
- 1.2.4** Inspect for chips, cracks, and broken insulators.
- 1.2.5** Record results on an approved PEARL Evaluation Form.

1.3 Phase and Neutral Bus

- 1.3.1** Inspect for signs of corrosion.
- 1.3.2** Inspect for signs of overheating.
- 1.3.3** Inspect all connections for missing hardware.
- 1.3.4** Check for a continuous current-carrying path.
- 1.3.5** Record results on an approved PEARL Evaluation Form.

1.4 Grounding Bus

- 1.4.1** Inspect for signs of corrosion.
- 1.4.2** Inspect for signs of overheating.
- 1.4.3** Inspect ground for missing hardware.
- 1.4.4** Check for a continuous current-carrying path.
- 1.4.5** Record results on an approved PEARL Evaluation Form.

1.5 Monitor Panel

- 1.5.1** Check all lens covers.
- 1.5.2** Check all light bulbs for operation.
- 1.5.3** Check all control knobs and switches.
- 1.5.4** Inspect for signs of rust and corrosion.
- 1.5.5** Inspect for signs of overheating.
- 1.5.6** Inspect all meters.
- 1.5.7** Inspect all control wiring for signs of deterioration and overheating.
- 1.5.8** Record results on an approved PEARL Evaluation Form.

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- 1.6 Cooling Fans**
 - 1.6.1** Inspect all control wiring for signs of:
 - 1.6.1.1** Deterioration
 - 1.6.1.2** Overheating
 - 1.6.1.3** Loose connections
 - 1.6.2** Check for proper lubrication.
 - 1.6.3** Record results on an approved PEARL Evaluation Form.
- 1.7 Tap Board**
 - 1.7.1** Inspect for signs of overheating.
 - 1.7.2** Inspect for signs of deterioration.
 - 1.7.3** Inspect for tracking and corona damage.
 - 1.7.4** Inspect for signs of corrosion.
 - 1.7.5** Inspect all connections for missing hardware.
 - 1.7.6** Record results on an approved PEARL Evaluation Form.
- 1.8 Core**
 - 1.8.1** Inspect for signs of corrosion.
 - 1.8.2** Inspect for signs of overheating.
 - 1.8.3** Inspect all connections for missing hardware.
 - 1.8.4** 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.

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Either Test; the “Overpotential Test” (Step 2.2) or the “Power Factor Test” (Step 2.3) must be performed. It is not a requirement to do both.

2.2 Overpotential Test

2.2.1 Connect all primary terminals together.

2.2.2 Connect all secondary terminals together.

2.2.3 Primary to secondary and ground test

2.2.3.1 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.

2.2.3.2 Record results on an approved PEARL Reconditioning Test Form.

2.2.4 Primary to secondary test

2.2.4.1 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.

2.2.4.2 Record results on an approved PEARL Reconditioning Test Form.

2.2.5 Secondary to primary and ground test

2.2.5.1 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.

2.2.5.2 Record results on an approved PEARL Reconditioning Test Form.

2.2.6 Record results on an approved PEARL Reconditioning Test Form.

2.2.7 Compare results to manufacturer's guidelines or industrial guidelines.

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

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- 2.3 Power Factor or Dissipation Factor**
- 2.3.1** Connect all primary terminals together.
- 2.3.2** Connect all secondary terminals together.
- 2.3.3** Primary to secondary and ground test (“GROUND” mode)
- 2.3.3.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL} and C_{HG}
- 2.3.3.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.3.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.4** Primary to secondary and ground test (“GUARD” mode)
- 2.3.4.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HG}
- 2.3.4.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.4.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.5** Primary to secondary and ground test (“UST” mode)
- 2.3.5.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL}
- 2.3.5.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.5.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.6** Secondary to primary and ground test (“GROUND” mode)
- 2.3.6.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL} and C_{LG}
- 2.3.6.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.6.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.7** Secondary to primary and ground test (“GUARD” mode)
- 2.3.7.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{LG}
- 2.3.7.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.7.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.8** Secondary to primary and ground test (“UST” mode)
- 2.3.8.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL}
- 2.3.8.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.8.3** Record results on an approved PEARL Reconditioning Test Form.

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2.3.9 Compare results to manufacturer's recommendations or industrial standards.

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

2.4 Transformer Turns Ratio Verification

2.4.1 Perform a 'turns ratio' test on each phase from primary to secondary on all taps.

2.4.2 Record results on an approved PEARL Evaluation Form.

2.4.3 Compare results to manufacturer's recommendations or industrial standards.

2.3 Core Ground

2.3.1 Perform a core ground test on each phase.

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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III RECONDITION 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 Clean all parts of contamination and corrosion.

1.1.3 Prepare the frame/enclosure to paint, as necessary.

1.1.4 Paint frame/enclosure.

1.2 Missing or Defective Components, Parts and Hardware

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

1.3 Molded Case Circuit Breakers

1.3.1 Molded case circuit breakers will be reconditioned in accordance with applicable PEARL Reconditioning Standards found in Section 1200.

1.4 Control Power or Instrumentation Transformers

1.4.1 Control power or instrumentation transformers will be reconditioned in accordance with applicable PEARL Reconditioning Standards found in Section 1400.

1.5 Surge Arrestors

1.5.1 Surge arrestors will be reconditioned in accordance with applicable PEARL Reconditioning Standards found in Sections 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 Test 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 Test 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 Test 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.

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Either Test; the “Overpotential Test” (Step 2.2) or the “Power Factor Test” (Step 2.3) must be performed. It is not a requirement to do both.

2.2 Overpotential Test

2.2.1 Connect all primary terminals together.

2.2.2 Connect all secondary terminals together.

2.2.3 Primary to secondary and ground test

2.2.3.1 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.

2.2.3.2 Record results on an approved PEARL Reconditioning Test Form.

2.2.4 Primary to secondary test

2.2.4.1 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.

2.2.4.2 Record results on an approved PEARL Reconditioning Test Form.

2.2.5 Secondary to primary and ground test

2.2.5.1 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.

2.2.5.2 Record results on an approved PEARL Reconditioning Test Form.

2.2.6 Record results on an approved PEARL Reconditioning Test Form.

2.2.7 Compare results to manufacturer's guidelines or industrial guidelines.

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

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- 2.3 Power Factor or Dissipation Factor**
- 2.3.1** Connect all primary terminals together.
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- 2.3.3** Primary to secondary and ground test (“GROUND” mode)
- 2.3.3.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL} and C_{HG}
- 2.3.3.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.3.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.4** Primary to secondary and ground test (“GUARD” mode)
- 2.3.4.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HG}
- 2.3.4.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.4.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.5** Primary to secondary and ground test (“UST” mode)
- 2.3.5.1** Perform a power factor or dissipation factor test at rated primary coil voltage or less to measure C_{HL}
- 2.3.5.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.5.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.6** Secondary to primary and ground test (“GROUND” mode)
- 2.3.6.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL} and C_{LG}
- 2.3.6.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.6.3** Record results on an approved PEARL Reconditioning Test Form.
- 2.3.7** Secondary to primary and ground test (“GUARD” mode)
- 2.3.7.1** Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{LG}
- 2.3.7.2** Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
- 2.3.7.3** Record results on an approved PEARL Reconditioning Test Form.

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- 2.3.8 Secondary to primary and ground test (“UST” mode)
 - 2.3.8.1 Perform a power factor or dissipation factor test at rated secondary coil voltage or less to measure C_{HL}
 - 2.3.8.2 Correct for temperature, if necessary. Refer to test set manufacturer’s literature.
 - 2.3.8.3 Record results on an approved PEARL Reconditioning Test Form.
- 2.3.9 Compare results to manufacturer's recommendations or industrial standards.
- 2.3.10 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.4 **Transformer Turns Ratio Verification**
 - 2.4.1 Perform a ‘turns ratio’ test on each phase from primary to secondary on all taps.
 - 2.4.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.4.3 Compare results to manufacturer's recommendations or industrial standards.
 - 2.4.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.5 **DC Winding Resistance**
 - 2.5.1 Perform a DC winding resistance test on each phase on all taps.
 - 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 **Core Excitation**
 - 2.6.1 Perform a core excitation test on each phase.
 - 2.6.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.6.3 Compare results to manufacturer's recommendations or industrial standards.
 - 2.6.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.7 **Core Ground**
 - 2.7.1 Perform a core ground test on each phase.
 - 2.7.2 Record results on an approved PEARL Reconditioning Test Form.
 - 2.7.3 Compare results to manufacturer's recommendations or industrial standards.
 - 2.7.4 The test results must be within the guidelines recommended in order for the product to become a PEARL labeled product.
- 2.8 **Molded Case Circuit Breakers**
 - 2.8.1 Molded case circuit breakers will be tested in accordance with applicable PEARL Reconditioning Standards found in Section 1200.

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2.9 Instrumentation and Controls

- 2.9.1** Verify the electric operation of all control lights.
- 2.9.2** Verify the electric operation of all control switches.
- 2.9.3** Test all cooling fans to verify operation at specific operating temperature set points.
- 2.9.4** Test all meters and monitors for proper functioning.
- 2.9.5** Perform an insulation resistance test to the control wiring at 1000 Vdc to ground.
- 2.9.6** Record results on an approved PEARL Reconditioning Test Form.

2.10 Control Power or Instrumentation Transformers

- 2.10.1** Control power or instrumentation transformers will be tested in accordance with applicable PEARL Reconditioning Standards found in Sections 1400 and 2400.

2.11 Surge Arrestors

- 2.11.1** Surge arrestors will be tested in accordance with applicable PEARL Reconditioning Standards found in Sections 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.