



The
Electrical
Power
Engineers

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TOTAL POWER FACTOR & HARMONIC SOLUTIONS

Qual-Tech Engineers has the unique ability to furnish a complete project from analysis to commissioning. All of the services required to assure an appropriate solution can be supplied. It could include a power factor and harmonic audit with recommendations on changes in system operating procedures, or it could include a complete turnkey solution including the equipment to solve the problem.

Turnkey responsibility will save the user time and money by providing convenience, scheduling management, and coordination of the project. Qual-Tech strives to provide solutions that are reliable and complete, that are flexible with regard to future system changes, and that have a self-protecting equipment package.



12.47 kV, 4th Harmonic Filter Banks –
Each with Two 1200 kvar Steps



Conversion of
4.16 kV, 1200 kvar Capacitor Bank to
1900 kvar, 4th Harmonic Filter Bank

Total Power Factor & Harmonic Solutions

1. **Power Factor Analysis**
2. **Harmonic Audit**
3. **System Analysis & Recommendations**
4. **Equipment & Installation Specifications**
5. **Equipment Package**
6. **Installation**
7. **Commissioning**

Qual-Tech Turnkey Advantages

- ◆ **One Point of Responsibility**
- ◆ **Reliable & Complete System Solutions**
- ◆ **Flexible Design for Future Changes**
- ◆ **Self-Protecting Equipment Package**
- ◆ **The Total Solution**

1. POWER FACTOR ANALYSIS

- *Determine Savings & Kvar Required*
- *Evaluate Power Factor Control Methods*
 - ◆ Adjust Transformer Taps
 - ◆ Adjust Field of Synchronous Machines
 - ◆ Do Not Oversize Motors or SCR Drives
 - ◆ Add Synchronous Condenser(s)
 - ◆ Add Capacitor Bank(s)
 - ◆ Add Harmonic Filter(s)



480 Volt, 400 kvar, 5th Harmonic
Metal-Enclosed Filter Assembly

2. HARMONIC AUDIT

- *Document Harmonic Producing Loads*
- *Review System Operating Conditions*
- *Document Future System Changes*
- *Review Harmonic Related Problems*
- *Measure Harmonic Distortion*
 - ◆ Average, Maximum, & Statistical Data
 - ◆ Background Distortion Levels

3. SYSTEM ANALYSIS & RECOMMENDATIONS

- *Simulate the System*
- *Evaluate Possible Alternatives*
- *Design Filters if Required*
- *Finalize Designs to Meet the Criteria*
- *Make Solution Recommendations*



13.8 kV, 3.5 Mvar, 11th Harmonic
High-Pass Filter Bank with
Enclosed Resistor on Top

Harmonic Related Problems

- Transformers & Motors Overheating
- Unexplained Fuse Blowings
- Nuisance Breaker Trips
- Electronic Equipment Misoperation
- Equipment Failure
- Telephone Interference

Methods of Controlling Harmonic Distortion

- No 3-Pulse or SCR/Diode Rectifiers
- Specify $I_{THD} < 40\%$ for 3-Phase Devices
- Reactance With SCR's To Limit Notch
- Delta/Delta & Delta/Wye Transformers
- 12-Pulse or Higher for Large Drives
- Avoid Resonance Conditions
- Apply Harmonic Filters

4. EQUIPMENT & INSTALLATION SPECIFICATIONS

- *Equipment Specification*
 - ◆ Complies with ANSI/IEEE Standards
 - ◆ Enclosure/Structure Suitable for Location
 - ◆ Self-Protecting Design Features
 - ◆ Enhanced Safety & Maintenance
 - ◆ Can Incorporate Customer Desired Features
- *Installation Specification*
 - ◆ Sets High Standard of Workmanship

5. EQUIPMENT PACKAGE

- *Metal Enclosed or Open Air*
- *Flexible Design for Future Changes*
- *Self Protecting Design*

6. INSTALLATION

- *Continuous Supervision of Contractors*
- *Coordination with Plant Activities*
- *Provide Foundations and/or Structures*
- *Equipment Delivery and Placement*
- *Connections to Electrical System*
- *Changes to Existing Electrical System*
- *Drawings (As Built)*

7. COMMISSIONING

- *Detailed Factory Equipment Checkout*
- *Detailed Field Equipment Checkout*
- *Harmonic Audit*
- *Power Factor Evaluation*
- *Operation & Maintenance Manual*



25 kV, 3 Mvar, 4th Harmonic Filter Bank
With Enclosed Air Core Reactor



138 kV, 62 Mvar, 5th Harmonic,
Open Air Filter Bank

Harmonic Limitations

- **System Harmonic Limits**
 - Voltage Distortion (5% at ≤ 69 kV)
 - Current Distortion (5% to 20% at ≤ 69 kV)
 - Limits 50% Higher For Short Periods
- **Equipment Harmonic Limitations**
 - Transformers (ANSI/IEEE C57)
 - Motors (NEMA MG-1)
 - Capacitors (ANSI/IEEE 18)

Solution Criteria

- Reduce Utility Bills
- Reduce System Losses
- Reduce Equipment Loading
- Increase Plant Uptime
- Increase Equipment Life
- Meet Harmonic Limitations

QUAL-TECH SERVICES

Power Systems Analysis & Measurements

- *Short Circuit & Coordination*
- *Arc Flash & Labeling*
- *Power Factor & Harmonics*
- *Load Flow & Stability*
- *Motor Starting, Transients, Flicker*
- *Problem Solving/Power Quality*
- *One-Line Diagrams*

Commercially available software systems are used for most analyses. For the convenience of our clients, it is possible to transfer the data files to the client if he has the same software.

Problem Solving

- *Equipment Failures*
 - *Unexplained Equipment Operations*
 - *Excessive Power Outages*
 - *Inefficient Operations*
 - *Need for New Solutions*
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Specialized Applications

- *Harmonic Filters*
 - *Static Var Systems*
 - *Arc Furnaces*
 - *Cogeneration*
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Specialized Turnkey Projects

- *Harmonic Filters*
 - *Power Quality Solutions*
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Power Systems Workshops

- *System Application Considerations*
- *Power Quality*