

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