Calculation of power supply radius of distribution box



Overview

Regional Grid Power Supply Radius Planning—A Sensitivity. By carefully planning regional power grid lines and accurately calculating their power supply.

Key Takeaways

The power supply radius of a distribution box is determined by transformer capacity, load density, voltage limits, and line losses, and can be calculated using voltage deviation or cost-optimization models.Key Factors Affecting Power Supply Radius
• Transformer Capacity: The rated capacity of the distribution transformer directly influences the maximum area it can supply. Higher capacity allows a larger radius under constant load density conditions ( ).

• Load Density: Areas with higher electricity demand per unit area reduce the effective supply radius, while low-density areas allow a wider coverage ( ).

• Voltage Drop: The permissible voltage deviation along the feeder line is a critical constraint. The radius must ensure that voltage at the farthest point remains within regulatory limits ( ).

• Line Losses: Resistance of conductors causes power loss, which increases with distance. Excessive losses limit the practical supply radius ( ).

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• Economic Considerations: Minimizing total cost, including transformer investment, line construction, maintenance, and reactive power compensation, is often part of the calculation ( ).
Calculation Methods1. Voltage Deviation Method

This method uses a nonlinear constrained optimization model:

• Objective: Minimize annual cost per km², including construction, maintenance, and losses.

• Constraints: Voltage deviation at the end of the line under maximum load and at the header under minimum load must remain within allowable limits.

• Procedure:
• Collect data: maximum load, load utilization hours, transformer capacity, conductor types, and costs.

• Model the network and calculate voltage drop along feeders.

• Adjust the radius iteratively until voltage deviation and cost criteria are satisfied ( ).

2. Load-Based Statistical Method
• Uses technical indicators such as line loss rate, average line load ratio, and voltage pass rate.

• Under constant load density, the supply radius increases with transformer capacity, largely independent of conductor cross-section ( ).
3. Cost-Optimization Approach
• Combines engineering investment and operational costs.

• Determines the radius that minimizes total cost while meeting voltage and reliability requirements.

• Can include reactive power compensation devices to improve voltage quality and reduce losses ( ).
Practical Considerations
• Urban vs Rural Networks: Urban areas with high load density require smaller radii to maintain voltage quality, while rural networks can have larger radii but may need reactive compensation ( ).

• Safety and Reliability: Ensure the design meets protection coordination, overload limits, and safety standards ( ).

• Future Expansion: Consider potential load growth to avoid frequent upgrades.
Summary

To calculate the power supply radius of a distribution box:

• Determine transformer capacity and load density.

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• Set voltage deviation limits and acceptable line losses.

• Choose a calculation method (voltage deviation, statistical, or cost-optimization).

• Model the network and iteratively adjust the radius to satisfy technical and economic constraints.

• Validate the design for safety, reliability, and future expansion ( ).

Article Content

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