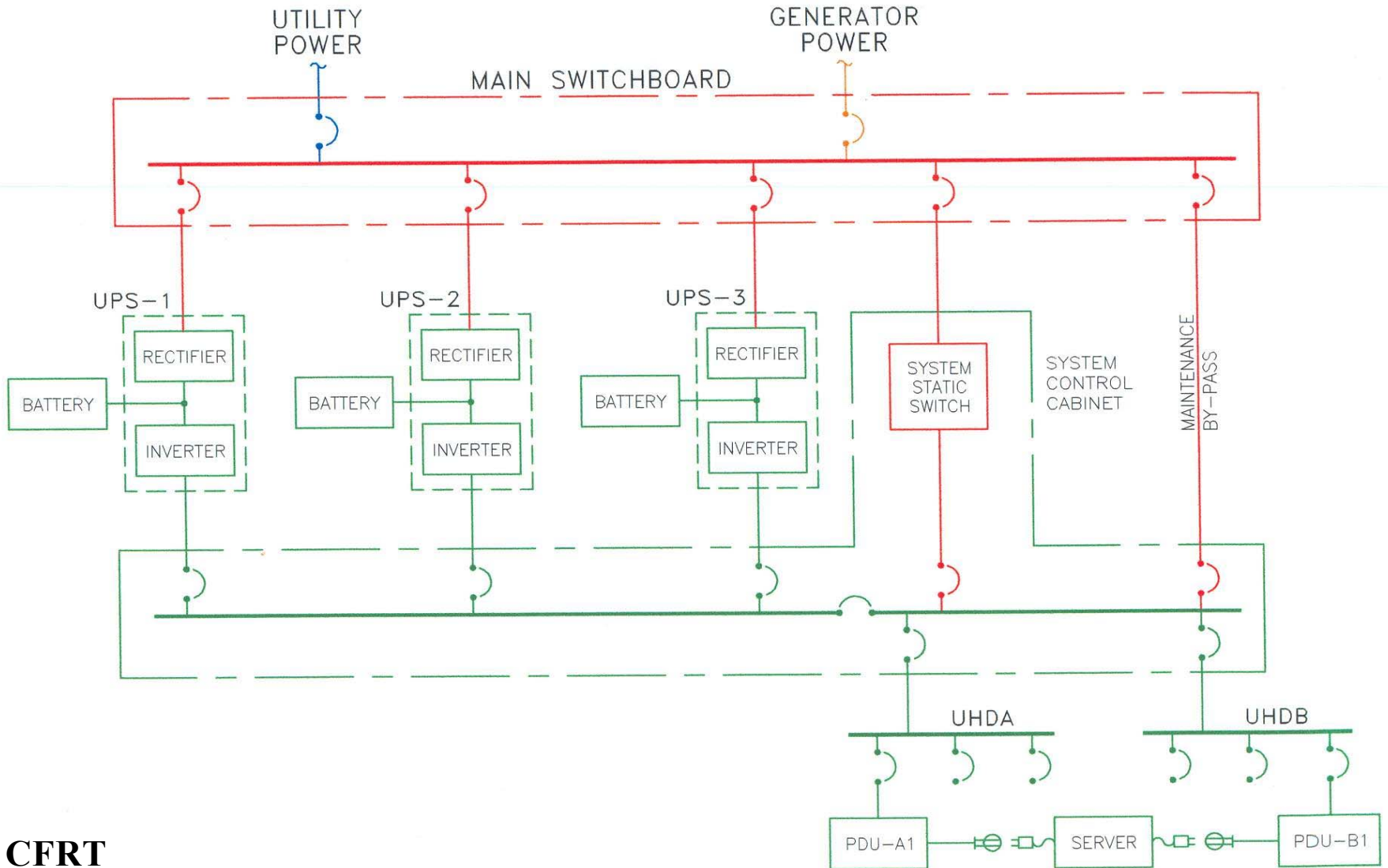


Chuck Shalley

The Engineering Enterprise

Parallel Redundant Configuration



Parallel Redundant UPS

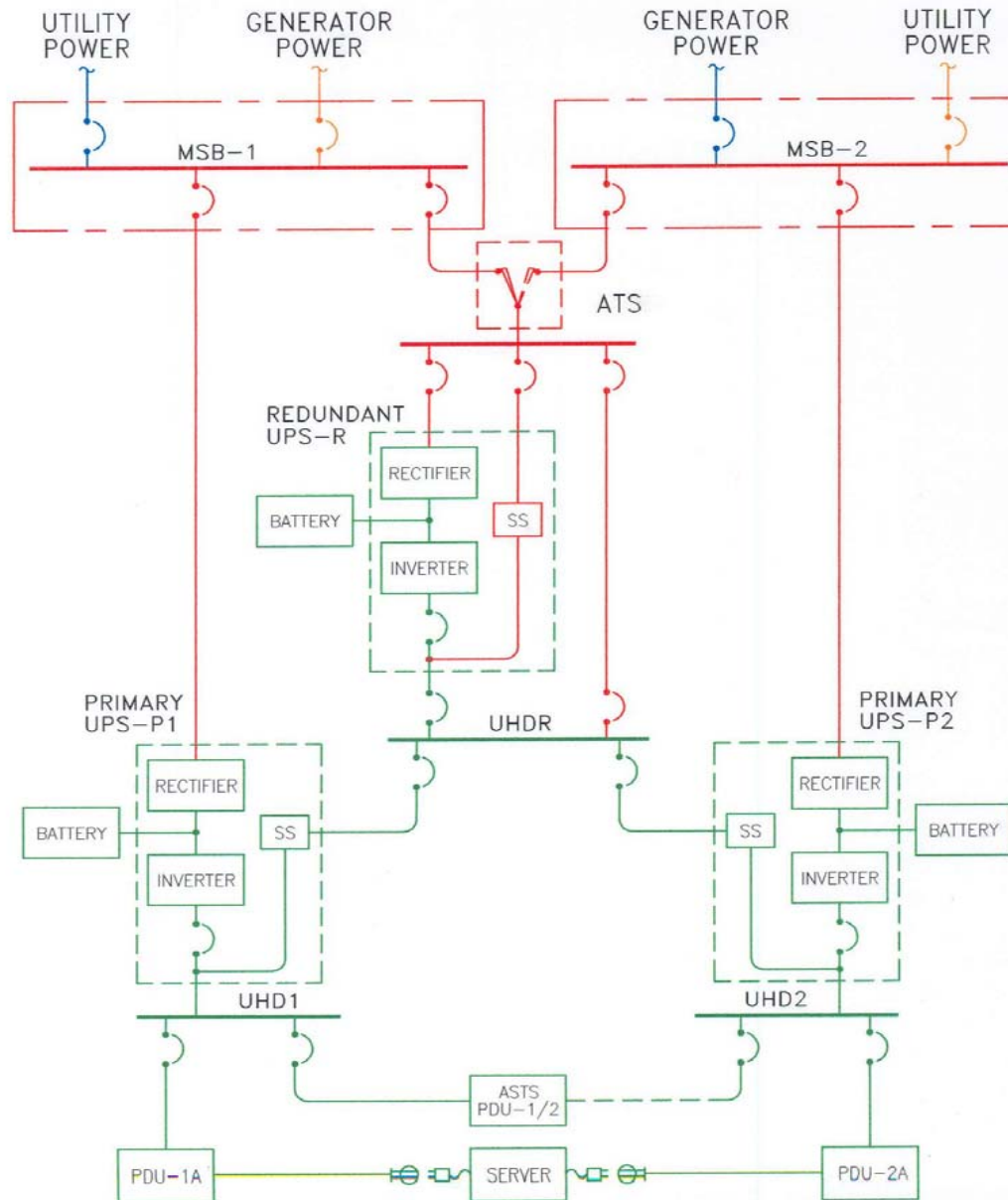
ADVANTAGES

- Load sharing capability
- N+1 redundancy of modules
- Expandability to match load requirements
- Simple, economical solution

DISADVANTAGES

- Single UPS output bus
- Not “downstream” fault tolerant
- Exposure to disturbances during maintenance periods (8 hrs./yr.)

Isolated Redundant Configuration



Isolated Redundant UPS

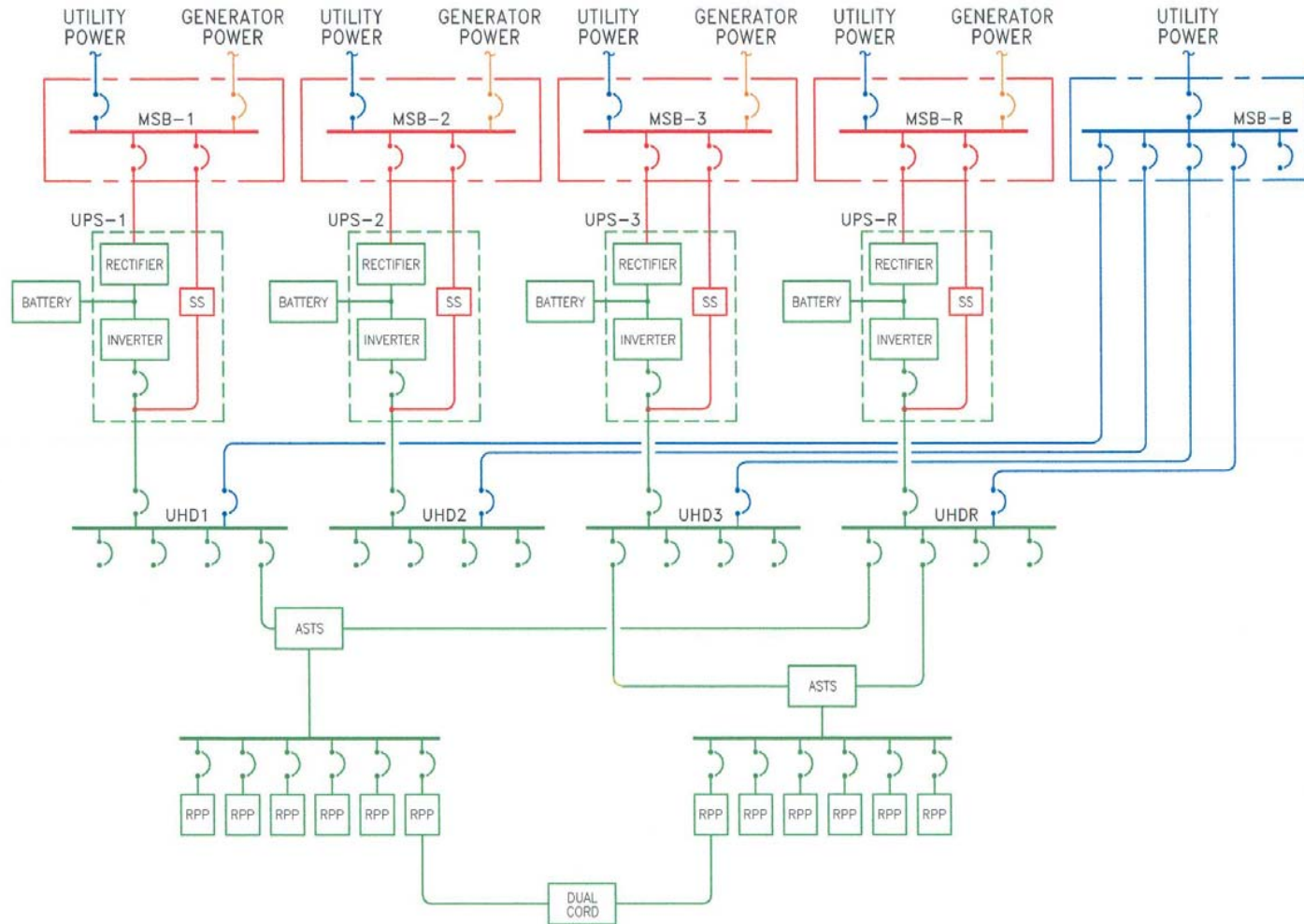
ADVANTAGES

- Multiple UPS output busses and power paths
- Yields high functionality at a reasonable cost
- Step load to redundant module for single failure is moderate
- Good fault tolerance

DISADVANTAGES

- Limited by KW rating of redundant UPS module or system
- Cascading failure upon redundant UPS module outage or loss of control (single synch system)
- Complex downstream distribution

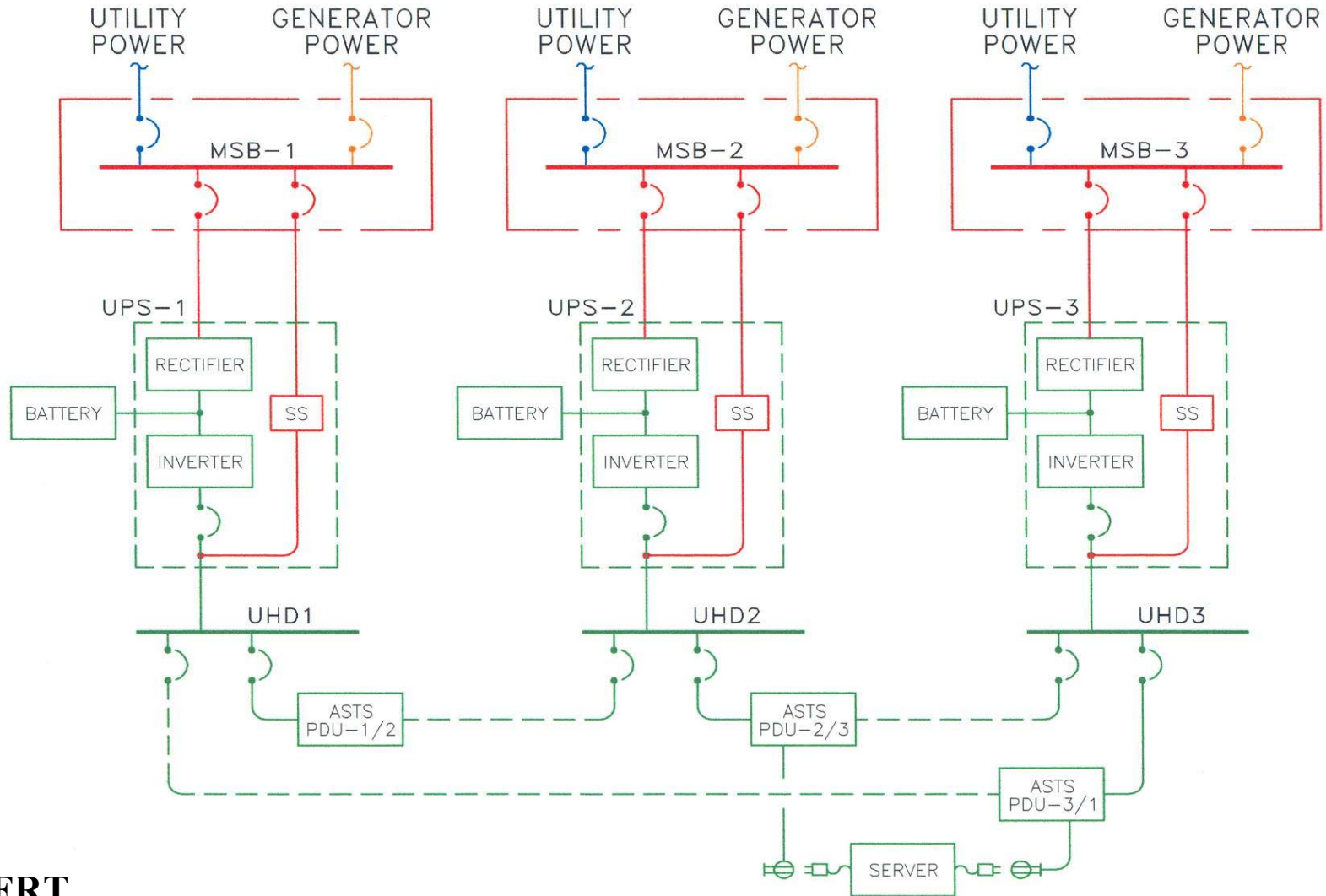
Block Redundant Configuration



Block Redundancy Configuration

- Design Overview
- Reliability Considerations
- Maintainability
- Cost Considerations

Distributed Redundant Configuration



Distributed Redundant UPS

ANTICIPATED RELIABILITY

- N+1 redundancy for all components.
- Very good independent /isolated UPS modules and downstream distribution.
- Each UPS has its own static by-pass switch.
- Downstream ASTS/PDU's are critical.

Distributed Redundant UPS

MAINTAINABILITY

- Outstanding due to “power cell” approach.
- One entire UPS system and downstream power distribution system can be isolated and deenergized.
- Easy to service and test.

Distributed Redundant UPS

EQUIPMENT COSTS

- N+1 redundant UPS system (3-1000 KVA) : \$600/KVA
 - Downstream redundancy: \$350/KVA*
- * Equipment price for ASTS's and 2nd PDU transformer for a 2000 KVA, N+1 power distribution system.

Distributed Redundant UPS

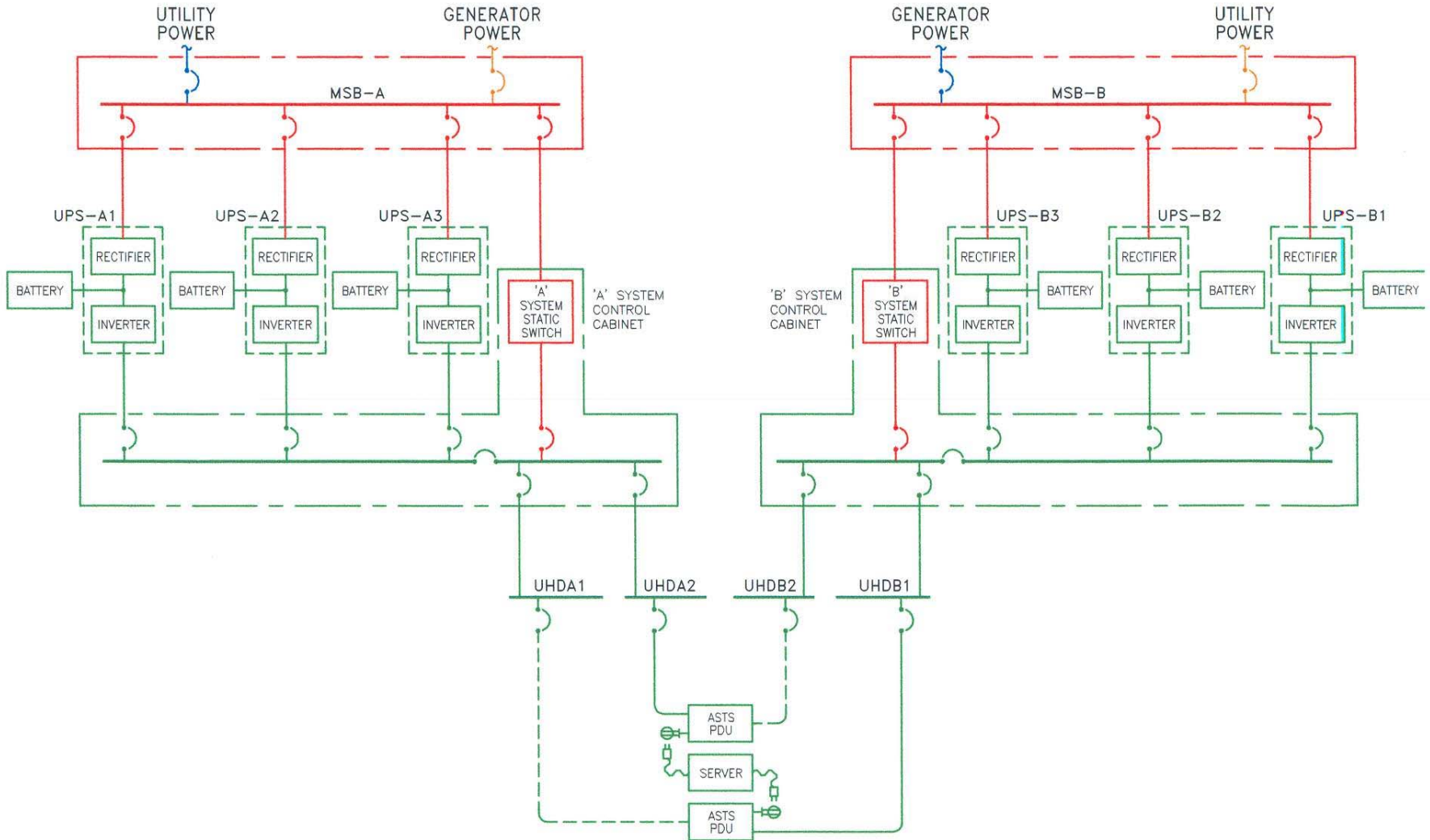
ADVANTAGES

- Good for large load applications...”power cells”
- Load sharing ability & expandibility
- Independent/isolated power paths
- Fault tolerant...N+1 throughout
- Ease of testing

DISADVANTAGES

- Sync control system is critical
- ASTS's required for redundancy
- Dual transformer PDU's are recommended
- Downstream distribution is costly

“2N” UPS Configuration



UPS Equipment Costs

UPS EQUIPMENT COSTS

- Small Systems (<750 KVA): \$550/KVA*
- Large Systems (>1500 KVA): \$600/KVA*

*Equipment purchase price, tax and mark-up for static UPS with 10 yr. VRLA battery for small systems and 20 yr. VRLA (Deka) battery for large systems.

DOWNSTREAM DISTRIBUTION EQUIPMENT

- \$350/KVA*

*Equipment price for ASTS's and 2nd PDU transformer for a 2000KVA, N+1 power distribution system.

2N UPS

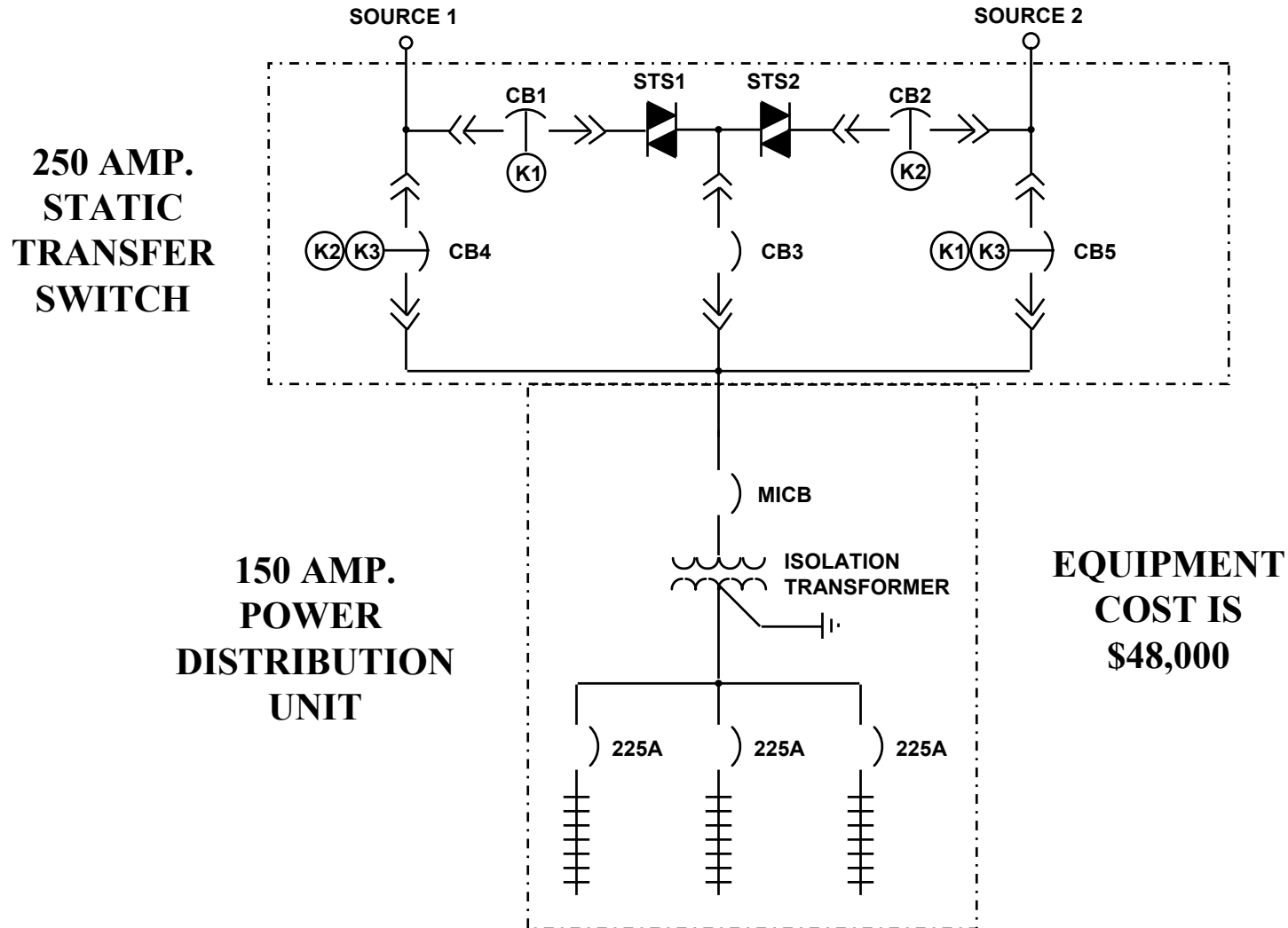
ADVANTAGES

- Multiple modules and multiple systems
- Complete “A” & “B” system separation
- Maintain redundancy...maintenance and failures
- Highly reliable...no cascading failures

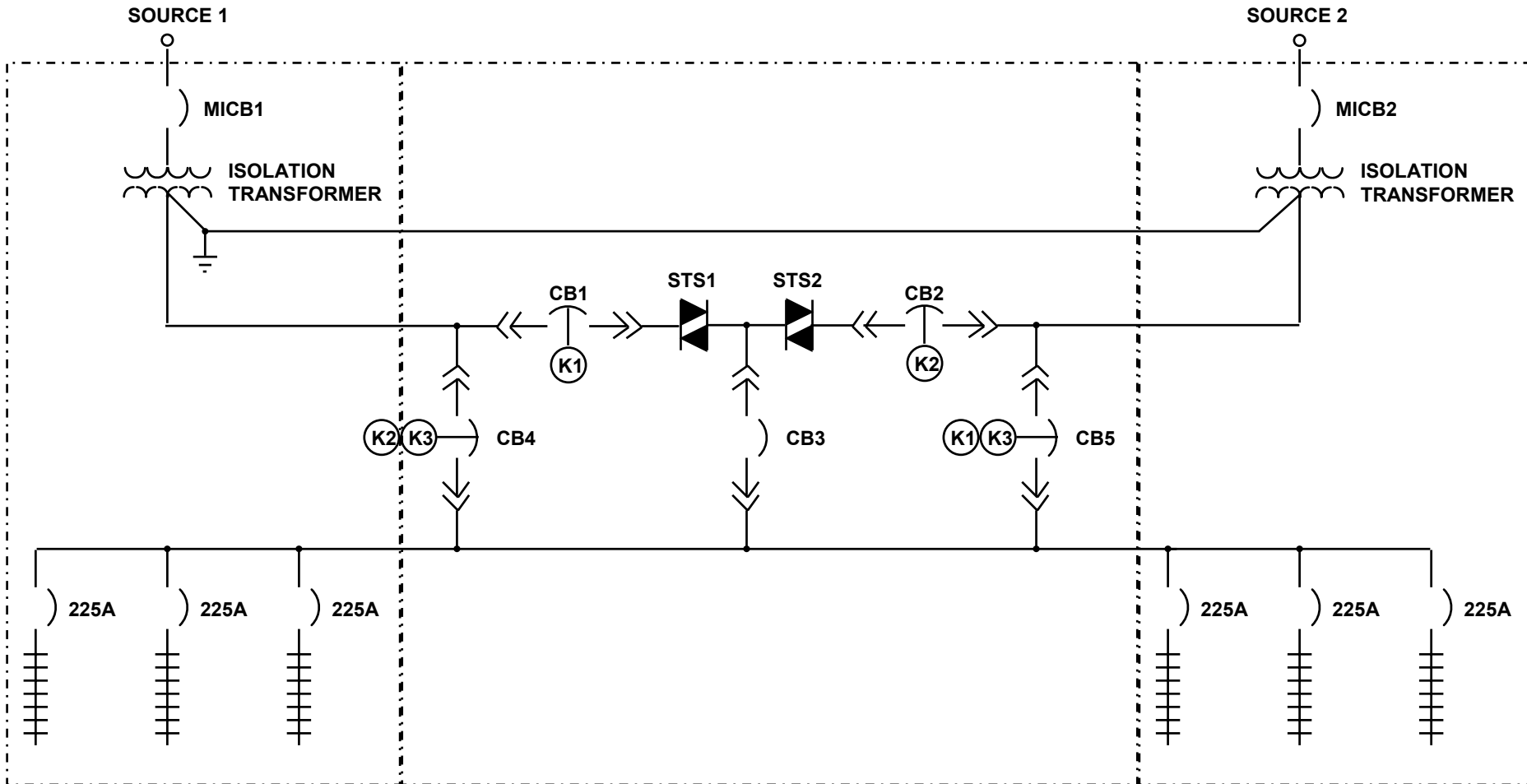
DISADVANTAGES

- Equipment intensive (40% used for load)
- Floor space requirements
- High cost

Automatic Static Transfer Switch on PDU Input



Automatic Static Transfer Switch on PDU Output



**PDU #1
150KVA**

**400 AMP. STATIC TRANSFER SWITCH
EQUIPMENT COST IS \$66,000**

**PDU #2
150KVA**

Fundamentals of High Availability Design

1. Configure Systems in Independent Blocks
2. Move Single Points of Failures as Close to the Load as Possible
3. Maintain Two Independent Sources of Power to the Critical Load
4. Keep it Simple/Minimize Human Intervention