Ministry of Government Services

Role of Batteries in a High Availability Data Centre Part II

INFOBATT 2007

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I&IT | Infrastructure Technology Services

Agenda.

- ITS General Overview
- Facilities Overview
- Battery Configuration
- Battery Duration Requirements
- Battery Room Construction
- Battery Reliability
- Power Loss Experiences
- Summary

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Who is ITS

Province of Ontario

Ministry of Government Services

Vision

An Ontario where people, information and technology drive innovation and excellence in public service

Mission

- Manage the government's investment in I&IT to optimize value
- Provide strategic advice and leadership on the effective use of I&IT
- Ensure the security and integrity of all systems and networks, and the protection of privacy
- Support business continuity, and effective business transformation
- Be socially responsible stewards of the public tryst and encourage transparency in all dealings
- Provide business solutions that deliver results

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What is “High Availability”

The “Nines”

5-nines	99.999%	uptime	5.26 minutes
4-nines	99.99%	uptime	52.56 minutes
3-nines	99.9%	uptime	525.6 minutes (8.76 hrs)

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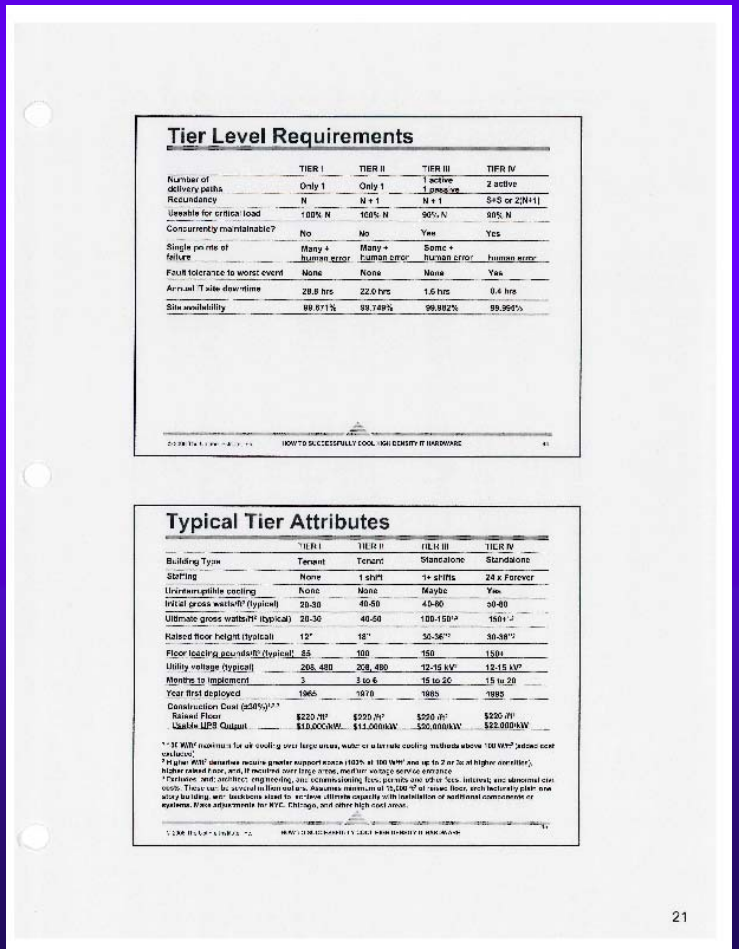
What is “High Availability”



Tier Level Requirements

	TIER I	TIER II	TIER III	TIER IV
Number of delivery paths	Only 1	Only 1	1 active 1 passive	2 active
Redundancy	N	N + 1	N + 1	S+S or 2(N+1)
Useable for critical load	100% N	100% N	90% N	90% N
Concurrently maintainable?	No	No	Yes	Yes
Single points of failure	Many + human error	Many + human error	Some + human error	human error
Fault tolerance to worst event	None	None	None	Yes
Annual IT site downtime	28.8 hrs	22.0 hrs	1.6 hrs	0.4 hrs
Site availability	99.671%	99.749%	99.982%	99.996%

HOW TO SUCCESSFULLY COOL HIGH DENSITY IT HARDWARE

Typical Tier Attributes

	TIER I	TIER II	TIER III	TIER IV
Building Type	Tenant	Tenant	Standalone	Standalone
Staffing	None	1 shift	1+ shifts	24 x Forever
Uninterruptible cooling	None	None	Maybe	Yes
Initial gross watts/ft² (typical)	20-30	40-50	40-60	50-80
Ultimate gross watts/ft² (typical)	20-30	40-50	100-150[2]	150+[2]
Raised floor height (typical)	12"	18"	30-36"[3]	30-36"[3]
Floor loading pounds/ft² (typical)	85	100	150	150+
Utility voltage (typical)	208, 480	208, 480	12-15 kV[4]	12-15 kV[4]
Months to implement	3	3 to 6	15 to 20	15 to 20
Year first deployed	1965	1970	1985	1995
Construction Cost (±30%)[1,2,3] Raised Floor	$220 /ft²	$220 /ft²	$220 /ft²	$220 /ft²
Usable UPS Output	$10,000/kW	$11,000/kW	$20,000/kW	$22,000/kW

[1] 50 kW/ maximum for air cooling over large areas, water or alternate cooling methods above 100 kW/ft² reduce cost variance.
[2] Higher kW/ft² densities require greater support space (100% at 100 W/ft² and up to 2 or 3x at higher densities), higher raised floor, and, if required, more building area, medium voltage service entrance.
[3] Partitions, and architect, engineering, and commissioning, fees, permits and other "soft" costs, inflation, and abnormal site costs. These can be several million dollars. Assumes minimum of 15,000 ft² of raised floor, and relatively plain one story building, with backbone sized to achieve ultimate capacity with installation of additional components or systems. Rises adjustments for NYC, Chicago, and other high cost areas.

HOW TO SUCCESSFULLY COOL HIGH DENSITY IT HARDWARE

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What has Changed

The Name

MBS is now MGS

iSERV became OCCSD & now ITS

The Scope

Primary Sites	4 + 1 new underway
Secondary Sites	16 transferred

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What has Changed

Toronto Delivery Centre

- UPS Power load increased significantly

  Sept 2005 430KW Sept 2007 570KW

  Projected to continue at this rate
- Second diesel for redundancy
- Additional new UPS units
- Replacement of older UPS units
- More and different batteries

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T.D.C. Space

	Approximate Sq. Ft.
•Total on Two Levels	60,000
• Main Floor (Level 2)	37,000
• Lower Level (Level 1)	23,000

Space Utilization

• Raised Floor	24,000
• Print Shop / Conditioned Storage	10,000
• Office space	20,000
• Mechanical / Electrical	6,000
•Includes 3 battery rooms	2,500

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T.D.C. Physical Security

- Undisclosed number of Cameras
- 7/24 monitoring
- Digital Image Recording / Retrieval
- Turnstiles with Anti-Pass back
- Proximity readers and Cards
- 4 levels of Access
  - Level 1 - Card
  - Level 2 – Card and Pin Number
  - Level 3 – Card, Pin # and Biometric Scanner (rooms or individual racks)
  - Level 4 – two people same as level 3

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T.D.C. Power

- Power Feeds
- Power Switchboard
- Diesel Generators
- UPS Protection
- Equipment Power Feeds
- Power Summary

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T.D.C. Power Feeds

- One Substation for entire complex
- Two dedicated 6000 amp transformers for Data Centre
- Connected to Split Switchboard
- All loads can now be moved to either transformer
- Backed up by Generators and UPS
- Average Monthly Consumption
  - 2005 685,000 KWH
  - 2007 1,041,000 KWH

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T.D.C. Power Switchboard

- Distributes Power from Transformers to equipment
  - UPS Units
  - HVAC Units
  - Data Centre Lighting
- Automatically Detects Power Outages
  - Starts Diesel Generators
  - Transfers Load to primary diesel when ready
  - Automatically transfers to secondary diesel on problems with primary
- Major modifications in 2006 to handle second diesel
  - Electrical and Mechanical Interlocks
    - (From 3 sources to 4 sources)
  - Modifications to bus bars for ground fault sensing

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T.D.C. Diesel Generators

Previous Configuration

- Caterpillar 69 litre V16 2018 hp Water Cooled Diesel
- 1600 KW Generator
- Fuel Capacity 1000 gal Run time at 100% load is 10 hrs
- Fuel Delivery when on Diesel scheduled every 6 hrs

Current Configuration

- 2 Caterpillar 69 litre V16 2018 hp Water Cooled Diesel
- Primary is 2000 KW secondary is 1600 KW
- Fuel Capacity 2000 gal primary 1000 gal secondary
- Run time at 100% load is over 24 hrs
- Fuel Delivery when on Diesel scheduled every 12 hrs

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T.D.C. UPS Protection

Previous Configuration

- Three Powerware 3300 UPS Units
  - •UPS 1 1 string of Exide Flooded cells
  - •UPS 2 1 string of C&D Flooded cels
  - •UPS 3 1 string of C&D Flooded cells
- UPS 3- manually switched backup for either 1 or 2
- Over 4 hrs run time on battery on C&D batteries
- Over 1 hr run time on Exide batteries

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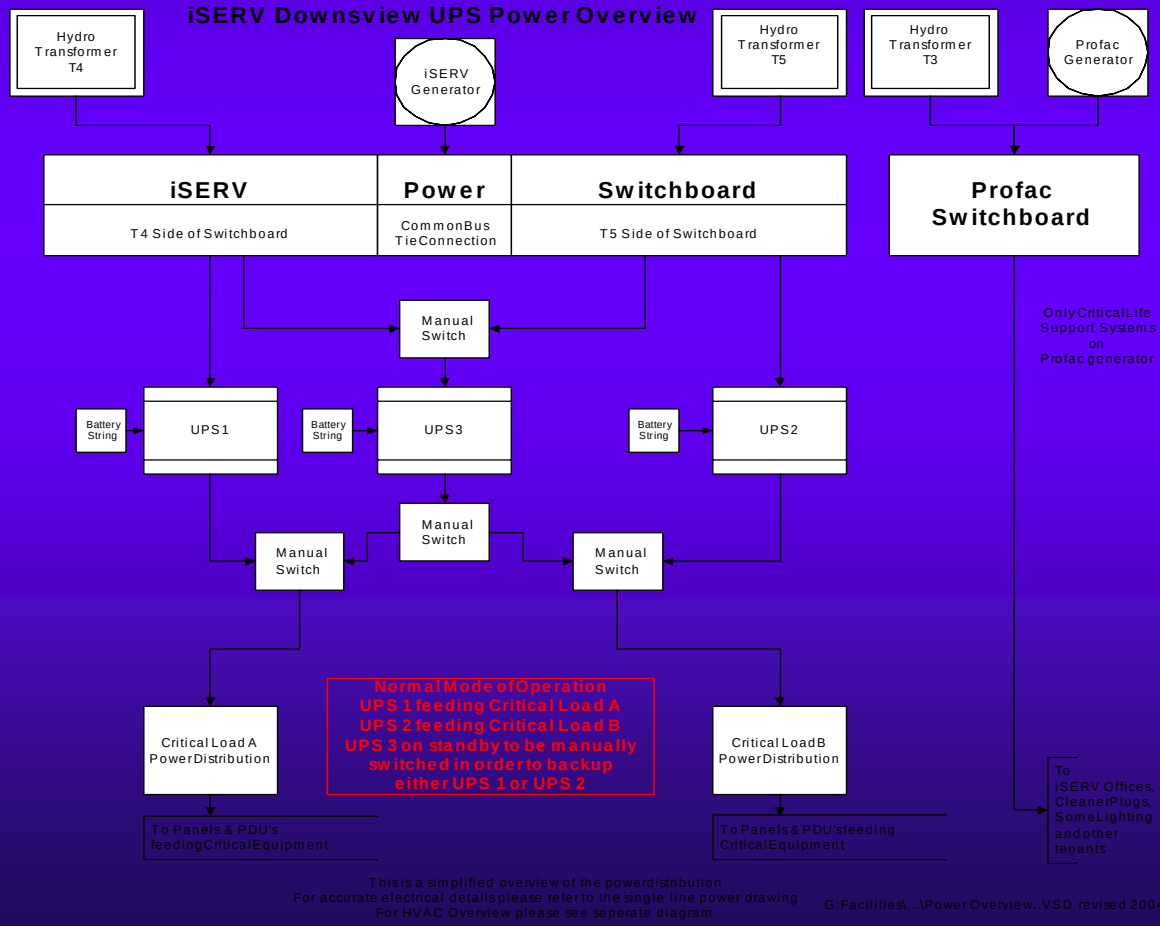
T.D.C. UPS Power 2005



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T.D.C. UPS Protection

Expansion Summer 2006

- Added 2 pairs of Parallel Redundant UPS Units
  - Eaton (Powerware) P160's
  - Each module has dedicated string of Batteries
    - 80 PWHR12390W4FR VRLA batteries
    - 30 minute run time at full load
- Parallel redundancy allows for
  - Load protected with loss of a module
  - Offline maintenance of module or battery string
- Increase Total UPS Capacity from 530KW to 790 KW

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T.D.C. UPS Protection

UPS 1 Replacement Spring 2007

- UPS1 destroyed by flood from main floor plumbing
- Load failed (single fed equipment only)
- Load moved to backup unit – UPS3
- Replaced with String of 4 parallel redundant P160 ’s
  - Each module has dedicated string of 80 PWHR12390W4FR VRLA batteries
  - 30 minute run time at full load on each module
- Parallel redundancy allows for
  - Load protected with loss of a module
  - Offline maintenance of module or battery string
- No impact on Total UPS Capacity

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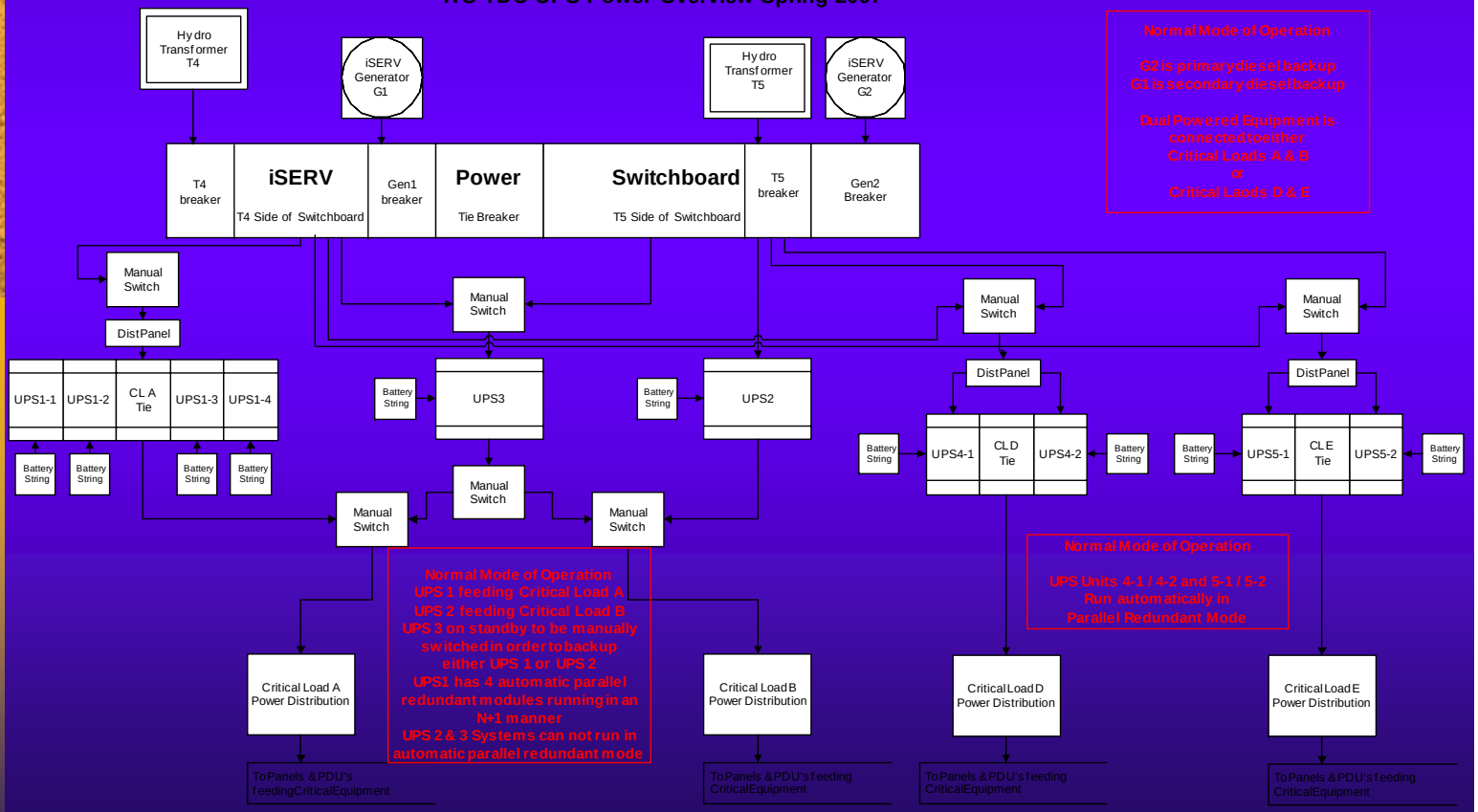
T.D.C. UPS Power 2007

ITS TDC UPS Power Overview Spring 2007



This is a simplified overview of the power distribution For accurate electrical details please refer to the single line power drawing
For HVAC Overview please see seperate diagram

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T.D.C. UPS Protection

Potential UPS 2 Replacement 2008

- UPS 2 load will be moved to UPS 3
- Replace with String of 4 parallel redundant P160 ’s
  - Each module will have 1 string of 80 PWHR12390W4FR VRLA batteries
  - 30 minute run time at full load on each module
- Parallel redundancy allows for
  - Load protected with loss of a module
  - Offline maintenance of module or battery string
- UPS3 will be removed once load on new UPS 2 string
- No impact on Total UPS Capacity

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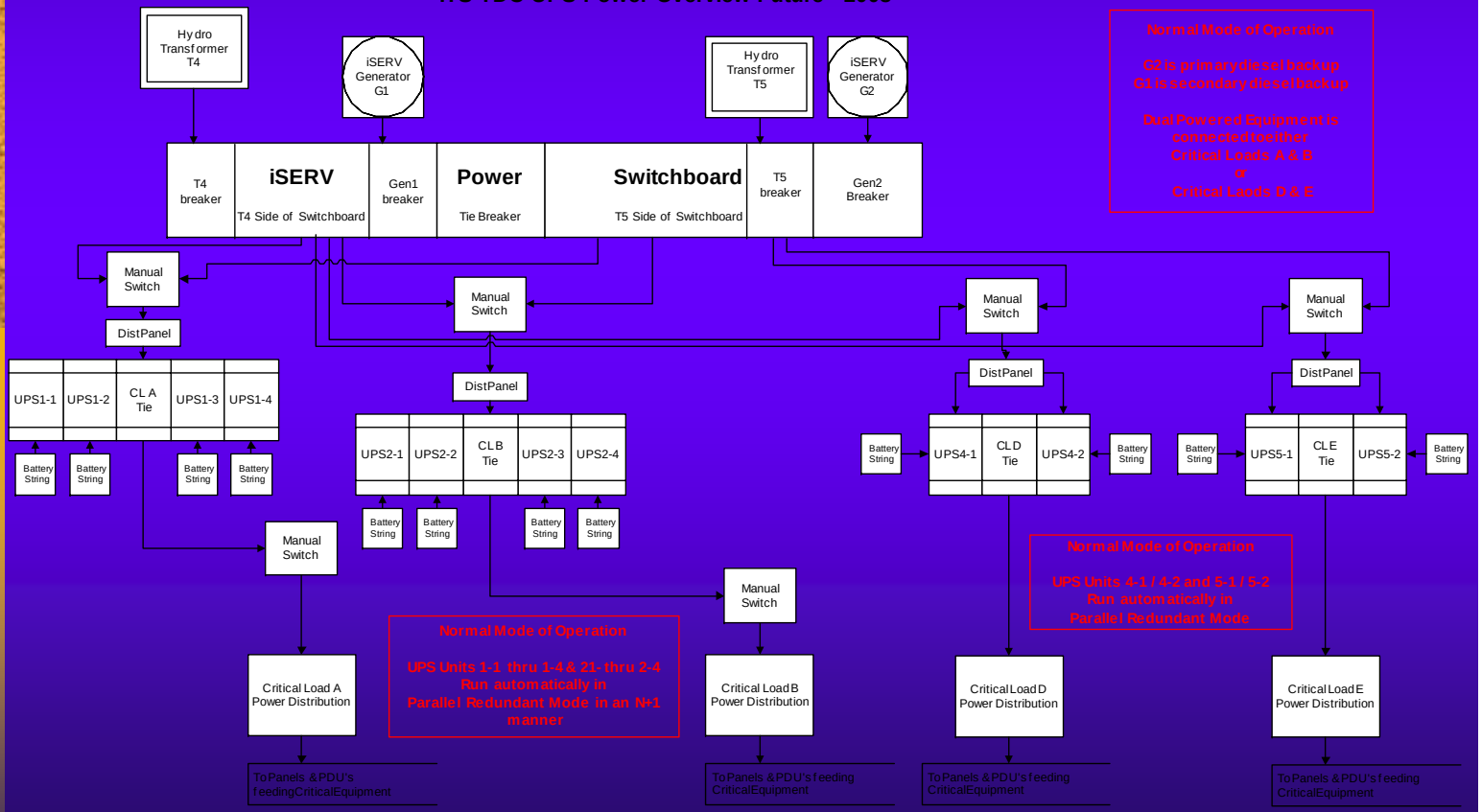
T.D.C. Potential UPS Power 2008

ITS TDC UPS Power Overview Future - 2008



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T.D.C. Equipment Power

- Each area of Data Centre Fed by 2 PDU units
  - 1 connected to Critical Load A or C
  - 1 connected to Critical Load B or D
- Standard Rack has 2 redundant Power Feeds
  - 1 connected to Critical Load A or C
  - 1 connected to Critical Load B or D
- Standard Equipment has 2 redundant Power Feeds
  - 1 connected to Critical Load A or C
  - 1 connected to Critical Load B or D
- If 1 Critical Load is lost, equipment keeps running

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T.D.C. Cooling

- 47 HVAC Units (37-22 ton, 4-10 ton, 6-5 ton)
- 884 tons of total cooling
- N+1 redundancy
- Groups of AC units controlled by external controllers
  - Rotate stanby operation
  - Auto start in case of problems
- Adjacent HVAC units fed from opposite power feeds
- HVAC power can be switched to Base Building Power
- HVAC power can be switched across power feeds

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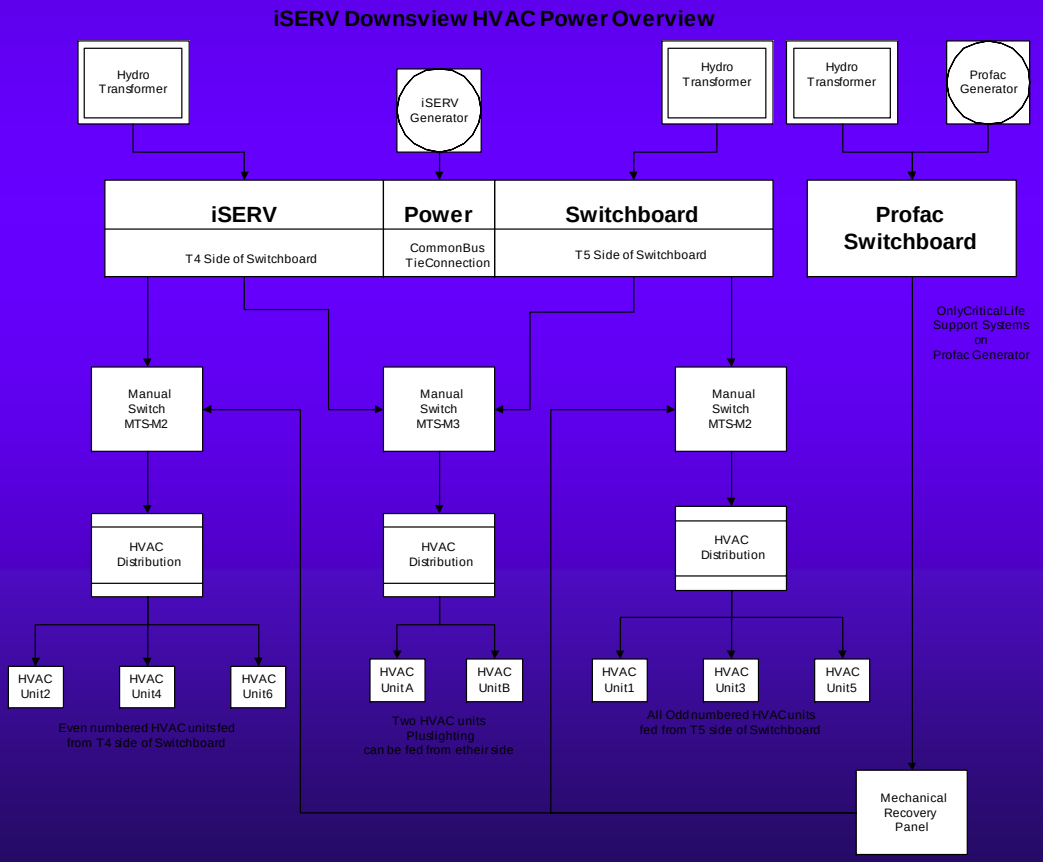
T.D.C. HVAC Power



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T.D.C. Fire Protection

- Detection
  - Separate Fire Panel for Data Centre
  - Connected to Building Fire Alarm System
  - Crossed Zone Detection
  - Smoke and Heat Detectors above and below floor
- Suppression
  - Zoned Dry Pre-action Sprinklers
  - Above and below floor Sprinkler Heads
  - Only Zone with alarm is Charged with Water
  - Only Individual Sprinkler Heads Opened
  - All old Halon has been removed

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T.D.C. Batteries

The Final Protection

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T.D.C. Batteries

- Battery Role
- Battery Configuration
- Battery Duration Requirements
- Battery Room Construction
- Battery Reliability

The Final Protection

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T.D.C. Batteries : Role

- Hydro Outages
  - Support UPS Load until Diesel is running
  - Support UPS Load when return to Hydro
  - Support UPS Load during Diesel Problems
- Other Outages
  - UPS feed breakers
  - Switchboard Problems
- Maintenance Activities
  - Support UPS Load for monthly Diesel tests
  - Support UPS loads during UPS Major PM (not required for parallel redundant UPS)
- Major Electrical Upgrades

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T.D.C. Batteries 2005 Configuration

- All 3 UPS units have flooded wet cells
  - UPS 1 - 1 string of 122 Exide 2DX3-33
  - UPS 2 – 1 string of 192 C&D PZ174E
  - UPS 3 – 1 string of 192 C&D PZ174E

- Each string of batteries dedicated to one UPS
- UPS 3 manually backs up UPS 1 or 2
- No parallel strings on UPS units

*i*SERV Ontario T.D.C. Facilities

Batteries – Configuration

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T.D.C. Battery Configuration

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T.D.C. Battery Configuration

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T.D.C. Batteries Current Configuration

- UPS 2 & 3 Configuration
  - •UPS 2&3 – 1 string each of 192 C&D PZ174E
  - •Each string of batteries dedicated to one UPS
  - •UPS 3 manually backs up UPS 1 or 2
  - •No parallel strings on UPS units
- UPS 1 4 & 5 Configuration
  - •Each module has 1 string of PWHR12390W4FR VRLA Batteries
  - •Battery string redundancy tied to module redundancy

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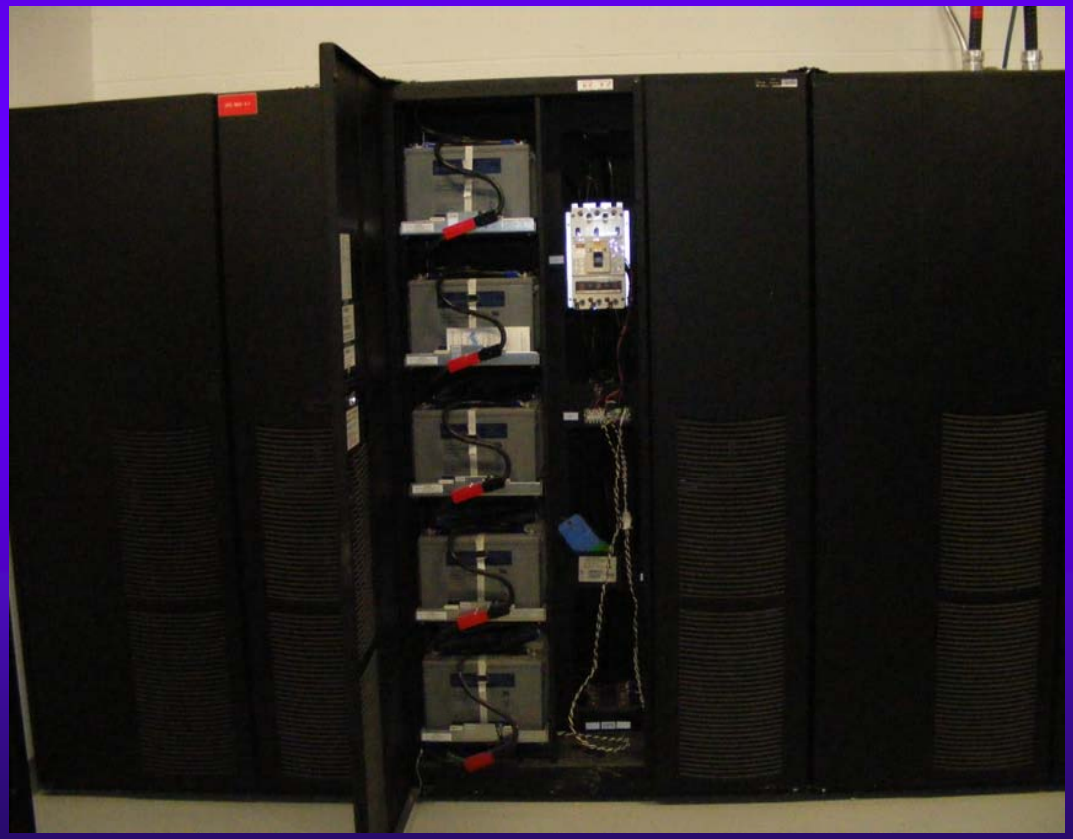
T.D.C. Battery Configuration



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T.D.C. Batteries: Duration

- Original battery strings provide > 4 hrs
- New UPS units have 20 minutes WHY?
- Redundant Diesels deemed better use of $$$$$
- Power Outages
  - Most are less than 2 minutes
  - Very few more than 15 minutes
  - UPS units draw on batteries for 2 minutes
  - Diesel backup then provides power
  - short draw when transfer back to hydro
- Examples where 20 minutes is NOT enough
  - Switchboard Modifications Spring 2006
  - Power Switchboard August 2001
  - Multiple Problems Dec 24 1999 (another site)

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Battery Room Construction

- Existing Conditions
  - Under floor Wiring Runs
  - Overhead Water
  - Water Shutoff Access
- Construction
  - Floor Coating
  - Concrete Dams
  - Racks
- Health and Safety
  - Eye Wash Stations
  - Water running alarm
  - Ventilation fans
  - Monitoring for gases

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Battery Room Construction

Old Battery Room

Note clearances

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Battery Room Construction

Wall Access Panel

Offset of batteries

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Battery Room Construction

Overhead Plumbing

Water tray with sensor

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Battery Room Construction

Concrete Platform

Concrete Dam

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Battery Room Construction

Eye wash station

Under floor wiring dams

Visual Posts

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Battery Room Construction

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T.D.C. Batteries - Reliability

- Critical link for power transfers
  - Normal Transfers to and from diesel
  - Transfer Problems
  - Diesel Problems
  - Electrical Upgrades

- Essential Issues Affecting Reliability
  - Inspections
  - Maintenance
  - Contractor Protocols
  - Lifecycle
  - Leaks

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T.D.C. Batteries : Reliability

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Role of Batteries in a High Availability Data Centre Summary

- Vital Link to keep everything running
- Budget Limitations focus spending on other areas
- Engineers provide minimal run time specs

- Strict attention to life cycle of batteries
- Strict Site Protocols
- Inspections

Its ALL up to US!

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Thank You for your Time

Any Questions?