



# Mission Critical Facilities Management

Principals of Design, Operations, and  
Maintenance

# What makes something mission critical?

- Various degrees of mission criticality
- Can be facility or system within a facility
- Some level of continuous operation be it eight hrs/day or 24/7/365
- Unavailability adversely impacts revenues, corporate image, regulatory compliance, safety, etc.



# 7x24 Availability

Requirement Due To:

- ✓ Financial Markets
- ✓ Internet
- ✓ International Business

Operational Responses:

- ✓ Dual Power Cord Equipment
- ✓ Comprehensive Disaster Recovery Programs - Mirroring
- ✓ Hardened Utility System – From 4-9s to 6-9s
- ✓ Eliminate Annual Maintenance Shutdown



# What makes something mission critical?

Mission critical functions include HVAC, power, security, controls, and communications.

# High Reliability Systems Definitions

**Redundancy** - the ability of a system to continue to operate even if one or more units fail – can be N+1, N+2, etc.

**7x24xForever** - the ability for a system to be maintained and upgraded without shut down of the critical load

**Fault Tolerance** – the ability of a system to continue to operate even if a single, inappropriate operation occurs - you can only approach this capability

**Capacity** - the ability to provide “Unlimited” capacity if required

# Design of Mission Critical Facilities

- ✓ Facility/systems are designed for reliability and availability.
  - Failure of any one device does not result in loss of system function.
  - Buildings and systems designed for hurricane, tornado, earthquake, fire, sabotage, utility outage, etc.
  - Higher factors of safety used when designing/sizing.

# Design of Mission Critical Facilities

- ✓ Key functions are automated and interlocked to prevent/reduce likelihood of human error and to preserve system function.
  - Generators automatically start on loss of utility power.
  - UPS provides seamless transition to emergency power.
  - Standby equipment automatically comes on-line.
  - Interlocks to prevent accidental defeat of redundant systems.

# Design of Mission Critical Facilities

- ✓ Designed to be more secure than their non-mission critical counterparts.
  - Remote sites often chosen.
  - Buildings often discreet with no signage or windows.
  - Access controlled at the site, building, and room level.
  - Continuous security, monitoring, etc.
  - Card readers and biometrics.



# Project Business Objective

Provide an overview of the current factors influencing the design of Mission Critical Facilities and a means to quickly determine if your Mission Critical Facility meets the present business requirements of 7x24xForever availability.

# Project Business Objective

- ✓ It is the Owner's responsibility
- ✓ Determine the operating requirements of the Mission Critical Facility
  - Tolerance for unexpected shutdowns
  - Realistic tolerance for scheduled outages
  - Clients supported - local, national, international
  - Strategic importance of the Mission Critical Facility - financial, regulatory and marketing

# Design Criteria

## Redundancy

If  $N = \text{Base Load}$

### System Design

$N + N$	Failure of an entire system does not result in a service interruption
$N + 2$	Failure of two units does not result in a service interruption (3 must fail)
$N + 1$	Failure of a single unit does not result in a service interruption (2 must fail)
$N$	Failure of a single unit results in a service interruption

# Outage Probability

<u>Reliability</u>	<u>9s</u>	<u>Downtime</u>	<u>% Probability</u>
<b>99%</b>	<b>2</b>	<b>87.6 hr/yr</b>	<b>100%</b>
<b>99.9%</b>	<b>3</b>	<b>8.76 hr/yr</b>	<b>99%</b>
<b>99.99%</b>	<b>4</b>	<b>52 min/yr</b>	<b>67%</b>
<b>99.999%</b>	<b>5</b>	<b>5.26 min/yr</b>	<b>10%</b>
<b>99.9999%</b>	<b>6</b>	<b>31 sec/yr</b>	<b>1%</b>

# Design Criteria

## Fault Tolerance

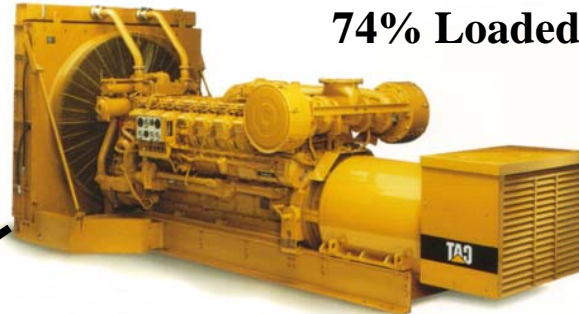
### System Design

Full	Any single failure or inadvertent operator error will not affect the critical load
Partial	Any single failure or inadvertent operator error may affect the critical load
Normal	Any single failure or inadvertent operator error will affect the critical load

# Standard N+0 Design



58% Loaded



74% Loaded



108 % Loaded

All existing systems N+0 (non-redundant)  
except for UPS which is N+1



95%  
Loaded



UPS Distribution 70% Loaded - Present  
system will not support dual power cord  
technology expansion

# State-of-the-art System



Present State-of-the-Art  
2N Data Center Design



# Design of Mission Critical Facilities

- ✓ Buildings and systems are designed to accommodate growth.
  - Additional capacity can be added with minimal or no shutdowns.



# Construction of Mission Critical Facilities

- ✓ Tight construction management and more quality control to ensure designs are not compromised.
- ✓ Extensive commissioning to validate systems perform as designed and to benchmark performance.



# Operation of Mission Critical Facilities

- ✓ Staffed 24/7 with relevant trades.
- ✓ Operators notified immediately of critical alarms through pagers, cell phones, or radios.
- ✓ Extensive training done to ensure operators understand system design and theory of operation.

# Operation of Mission Critical Facilities

- ✓ SOPs and contingency plans guide operator actions. No flying by the seat of your pants.
- ✓ Operator actions documented at all times to support accountability, auditing, and root cause analysis.
- ✓ Procedure compliance is reinforced by management.

# Operation of Mission Critical Facilities

- ✓ Documentation in the form of drawings, systems descriptions, SOPs, contingency plans, etc., readily available and updated as changes are made to facility/systems.
- ✓ Emphasis on continuous process improvement and root cause analysis to prevent recurrence of operator error.

# Maintenance of Mission Critical Facilities

- ✓ Scope and frequency of preventive maintenance is based on failure modes and effects, duty cycle, vendor recommendations, work history, and regulatory requirements.
- ✓ All wear/failure mechanisms evaluated to avoid maintenance preventable failures.



# Maintenance of Mission Critical Facilities

- ✓ Emphasis is placed on condition-based maintenance.
- ✓ CMMS used to plan, schedule, and document completion of all work.
- ✓ Work order documentation supports continuous process improvement and auditing of program effectiveness.

# Maintenance of Mission Critical Facilities

- ✓ Controls placed around performance of high-risk maintenance.
- ✓ Post maintenance testing when applicable.
- ✓ Spare parts based on repair scenarios.

# Maintenance of Mission Critical Facilities

- ✓ Changes/deferrals are justified and approved by management prior to being carried out in the field.
- ✓ Program compliance and effectiveness is measured by management. Opportunities for improvement identified and acted on.

# Five Realities

1. The owner lives with the results – even if blame can be determined, the facility has suffered.
2. The lowest cost is doing it right the first time.
  - If the project cost is initially minimized, it will eventually cost more to upgrade the system due to down time.
3. You can't afford to do it wrong.
4. Once the facility is operational, it is extremely difficult and most likely impossible to implement system upgrades for capacity, 7x24xForever capability, redundancy and fault tolerance without a major (days) shut down.
5. Comprehensive testing will be done either before, during or after the facility goes live. Let's make it before!!!