Dealing with Aging Electrical Infrastructure

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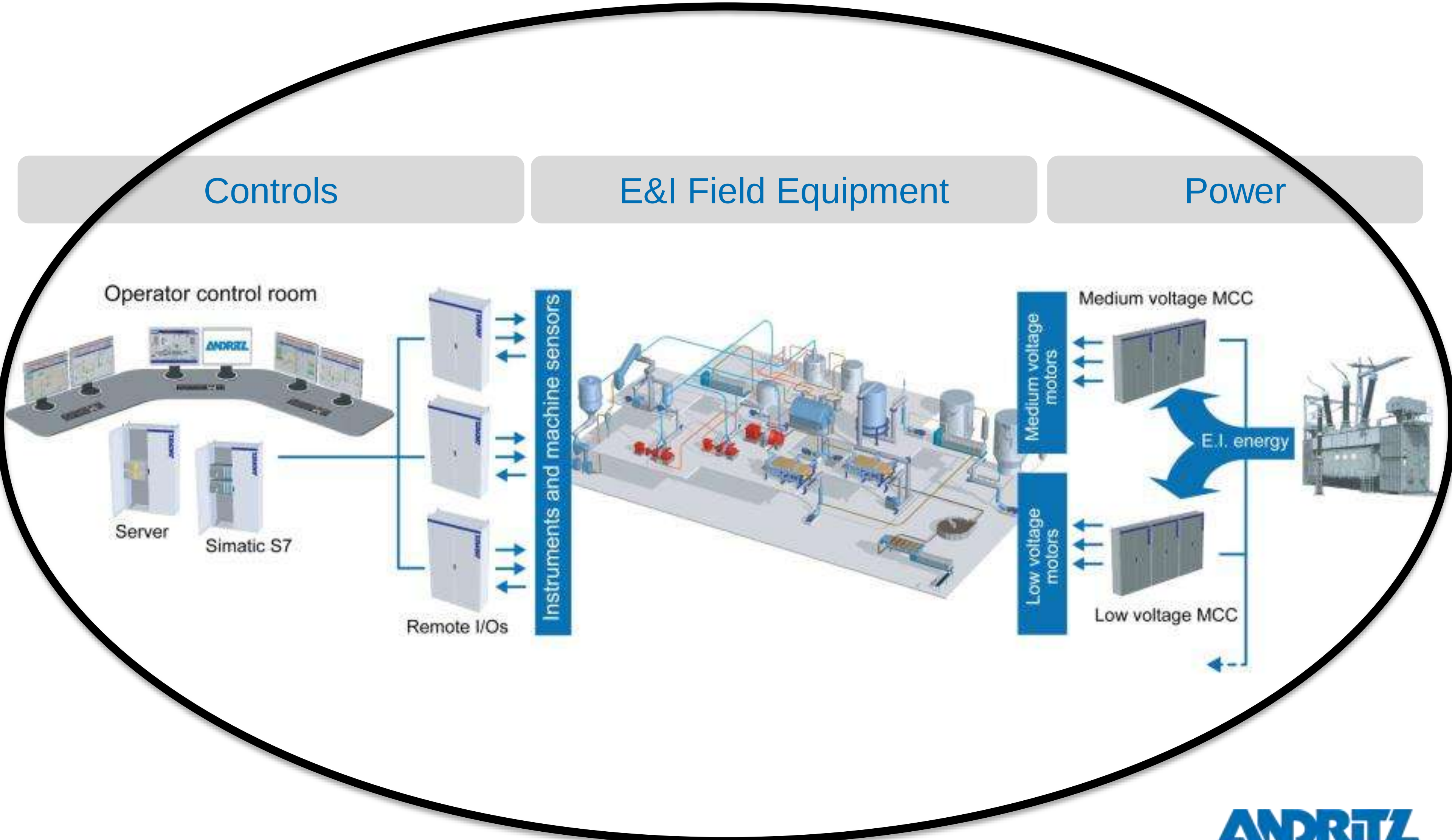
Contents

Background

Definition of Infrastructure:

- "A set of interconnected structural elements that provide framework supporting an entire structure."
- In terms of an electrical system we can define them as:
  - Substation
  - Power Distribution
  - Control System and Networks
  - Field Devices and Instrumentation
  - Wiring Systems

Electrical Infrastructure



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Issues

- Hard to get money approved to fund infrastructure replacement
- Interruption of operations can be minimized with proper planning but is un-avoidable.
- Depending on the size of the facility and the scope of the upgrades they often require multi-year staged solutions
- Requires a strong commitment from management to stay the course

Assessment

Do you know where you are starting from or is an audit required?

System Documentation and Baseline

- Power System Model
- Plant wide Motor & Load List
- Process Flow sheets or P&IDs
- Instrument/Device List
- I/O List

Assessment

How do we sell it upstairs?

Define your Assessment Criteria

- Equipment Reliability
- Maintenance
- Safety Systems
- Ability to absorb planned Growth

Assessment

How Much does this Cost?

Assessment

Methods of Assessment

There are complex methods to assess reliability

Reference – IEEE Gold Book

- Statistics for Mean times between failures for Specific Equipment
- Statistics for Mean time to repair failures
- Can use facility downtime/Hour figures to examine potential costs
- Can use these types of methods for justification

Assessment

Methods of Assessment

TABLE II
PUMPHOUSE CUT-SETS OF EXISTING ELECTRICAL SYSTEM

Cut Set	λ Failures per year	Critical Demand period months/year	Adjusted λ Failures per year	Annual Probability of Failure F1	30-year Probability of Failure F30
1. Loss of switchgear PDP#401-1	0.01428	6	0.00714	1:140	1:5.2
2. Loss of main and standby transformers	2.0 E-6	6	1.0 E-6	1:1.0 E+6	1:33,333
3. Loss of traveling screen motor	0.0824	1	0.00687	1:146	1:5.4
Pumphouse Totals			0.014	1:72	1:2.9

TABLE III
ANNUAL RISK COST SUMMARY FOR PUMPHOUSE SWITCHGEAR

Description	Annual Probability of Failure	Single Loss Cost	Annual Risk Cost ARC
Existing installation	1:140	$100 million	$714,000
Upgrade Option #1	1:1.25 E+6	$100 million	$80
Upgrade Option #2	1:1470	$100 million	$68,000

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Assessment

Simple Assessment Method – By elements

Good	0
Consideration	1
Partial Upgrade Required	2
Full Upgrade Required	3
Hazardous or Must Do	4

Category Weights	Arc Flash	Personnel Safety	Reliability	Maintenance	Code/Regulatory	Environmental	Other
	1.5	1.5	1.25	1	1	1	0.75

Identified Area of Concern	Notes	Arc Flash	Personnel Safety	Reliability	MSHA Issues	Code/Regulatory	Environmental	Other	Priority Rating
Main Substation - TFRs		2	2	2	0	0	3	1	12.25
Main Substation - Switchgear		4	3	3	0	1	0	2	16.75
Main Substation - Structure/ Grounding									0
Distribution Feeders/Cabling									0
Distribution Equipment (TFRs & PDCs)									0
Electrical Rooms									0
Motor Control Centres									0
Motor Branch Circuit Wiring Systems									0
Instrumentation and Control Devices									0
Control System Wiring									0
Conrol System Hardware									0
Control System Network Wiring									0

Assessment

Simple Assessment Method – By Process Areas & Elements

Good	0
Consideration	1
Partial Upgrade Required	2
Full Upgrade Required	3
Hazardous or Must Do	4

Category	TFRs	Switchgear	Feeders	MCCs/PDCs	Controls	Field Devices	Wiring Systems	Maintenance
Weights	1.5	1.5	1.25	1.25	1	1	1	1

Identified Area of Concern	Notes	TFRs	Switchgear	Feeders	MCCs/PDCs	Controls	Field Devices	Wiring Systems	Maintenance	Priority Rating
Process Area 1		1	3	2	*3*	3	0	0	2.5	17.75
Process Area 2		0	0	1	*1*	3	2	2	2	11.5
Process Area 3										0
Process Area 4										0
Process Area 5										0
										0
										0
										0
										0
										0
										0
										0

Assessment

Analyze the Assessment Results

Questions to Ask

- What is the expected operating life of the facility?
- Lifespan will help determine the extent and degree of upgrades
- Based on outcome of the assessment and Operations needs, formulate a preliminary plan of execution based on defined priorities

Planning Considerations

If this was a new facility, would it be designed the same way?

Design Criteria

- Utilization Voltages
- System Grounding Methods
- MV Motors
- Drive Systems
- Cabling Methods
- Process Area Segregation
- Critical Loads

Planning Considerations

What New Technology do you want to implement?

New Technology

- Control System Hardware/Software Upgrade
- Fiber Optic networks
- Smart Transmitters
- Smart MCC's
- Digital Protection Relays and Power Metering
- Arc Flash Rated Distribution Equipment

Planning Considerations

Estimate Costs

- Directly Purchased Equipment
- Installation Materials and Labour
- Internal Resources for Labour or External Contractor?
- Construction Management
- Engineering
- Define Accuracy of Estimate
- May need to consider escalation if duration is several years

Planning Considerations

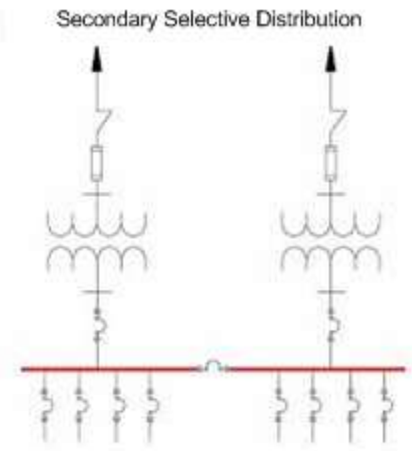
Other Considerations

Future growth and expansion requirements?

- What capital plans are underway that will impact infrastructure requirements
  - New Process Areas
  - Mechanical Upgrades impacting connected load

- Consider them now as you can plan for future expansion requirements should they come about

- Engage other internal groups early in the process to get buy-in



Constructability

How do you minimize impact on existing operations

This will depend on the level of upgrades required and the plant physical limitations

- Look for physical space to build the new system in parallel
- Once in place, cutovers from old to new can be scheduled and possibly aligned with other planned outages
- Utilize Process Area Buffers in your system segregation design to buy cutover time and also future shutdown isolation

Summary

Process Workflow

To Summarize the Approach:

If required perform an audit to baseline the current system

- Analyze the current system needs or deficiencies
- Define the new design methods/approach
- Define new technology to implement
- Do a ROM estimate of the costs
- Consider constructability issues and operations impact
- Define a work package scope and rough schedule
- Duration of overall plan will be determined by cash flow requirements and coordination with regularly planned outages

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Summary

Set the Goal Posts

Define the level and degree of the overall objective of the infrastructure upgrade

- Keep the final objective in mind
- Insure that people are aware of the long term goals
- Recognize that delays may occur due to economic situations
- Stick to the plan

Summary

We can do this with our existing resources

This decision should be carefully though through and will vary depending on the situation

- Don‘t underestimate the amount of work required
- Is you organization really set up to assess, plan and execute the required upgrades?

Case Study

US Customer

Plant originally built in the 1940's and underwent 2 major expansions from previous Owners (3 in total)

Plan & Roadmap for a Long Term Upgrade

- Plant Audit to update documentation
- New Control System and Network defined
- New Substation and distribution system defined
- New Electrical Rooms with New Smart MCCs
- Review and addition of some field devices
- Re-wiring of field devices required
- Preliminary Design and Capital Cost Estimates completed for submission for capital funding
- Process Segregation included in new design for controls and power distribuon
- Six different procs areas defined and long term multi-phase upgrade plan finalized.

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Case Study – Substation & Switchgear

Before – circa 1940's

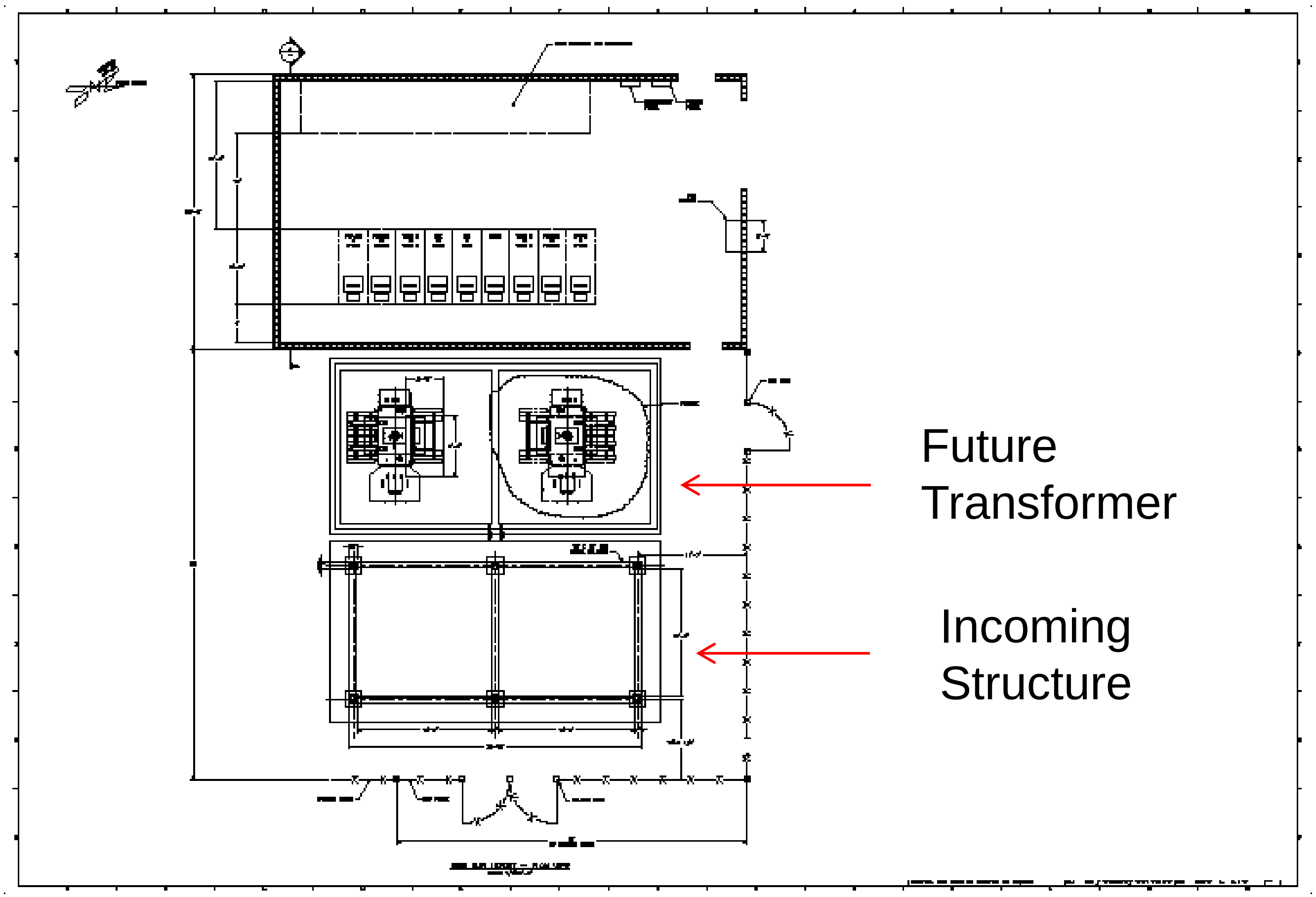
- Old Structure
- Multiple dedicated transformers nearing end of service life
- 2400V and 480V secondary
- Indoor & Outdoor Switchgear
- Main distribution at 480V

After (Soon) – circa 2014

- New Incoming Structure to be installed
- New Main TFR
- Provision for Future 2nd TFR
- Building with new 5 kV switchgear
- Main Distribution at 4160V

Case Study Substation & Switchgear

Layout with Structure & Future Transformer



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Case Study – Substation & Switchgear

Before – circa 1940's

- Main 480V Air Circuit breakers
- Arc Flash hazard
- Long 480V feeders to local MCC Locations

After

- New building housing switchgear
- Room for expansion for future loads
- New 5 kV vacuum breakers
- Main Distribution at 4160V
- New Underground duct bank feeder system

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Case Study – Distribution & MCCs

Before

- Original Distribution Feeders at 480V From main substation
- MCC's installed in open process areas

After

- New Electrical Rooms for 480V PDC's and New MCC's segregated by Process area
- New Operator Control Room on second level

Case Study - Controls

Before

- Old Control Room with Mimic Panel
- Some PLCs for one process Area

After

- New Control Room under Construction
- Controls Upgrade will be staged based on process areas defined in plan

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Thank You!


Simulation
Electrical
and Controls
Operator
Training
Optimization