Development of Self-Correcting Building HVAC Controls

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Project Objectives

- Develop and laboratory test algorithms that implement self-correction capabilities for subsystems of HVAC systems
- Prove that self-correcting algorithms can be developed and implemented for the target HVAC systems

Outcomes

- Algorithms ready for implementation in controllers for field demonstration and commercial application
- Underlying methods that may be transferable to creating self-correcting capabilities for other HVAC system components
- Many (“soft”) faults eliminated when technology is deployed in the field.
- System operation optimized while other (“hard”) faults occur, until physical repairs can be made.
- Energy and cost savings.

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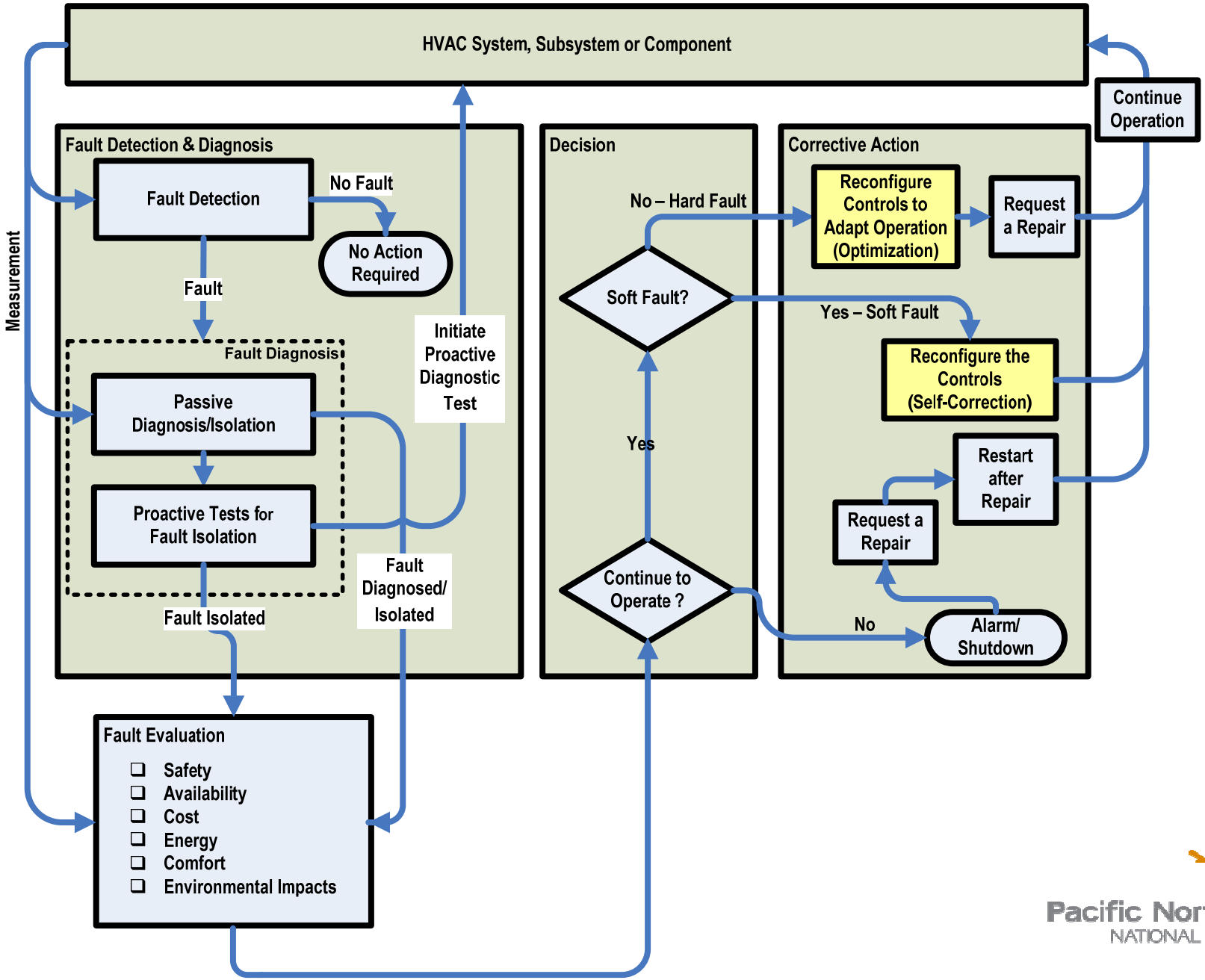
What are Self-Correcting Controls?

- Control systems that automatically compensate for faults in sensors, actuators, control code, control parameters and physical equipment
  - Maintain operation of the controlled system at peak performance or at a degraded performance
  - Better than the system would operate without the automatic self correction.
- Examples from other fields:
  - Fighter jet able to land safely after losing a wing.
  - Commercial jet able to land safely after losing all hydraulics.
  - Automatic stability control in automobiles.
- Value for buildings:
  - Keep HVAC systems operating efficiently when faults occur, until service personnel can repair them
  - In some cases, completely compensate for a fault to enable continued peak performance when a component's performance degrades (e.g., a temperature sensor that drifts out of calibration)
  - Save energy and dollars

Essentials of Self-Correcting Controls

- Redundancy is essential to achieve fault tolerance or self-correction
- Types of redundancy
  - Physical or hardware redundancy – provided by identical back-up components
  - Analytic redundancy – provided by analytic models of processes
- Today for HVAC systems and equipment:
  - Physical redundancy is unlikely because of cost
  - Analytic redundancy is possible
- Four Steps to Self Correction
  - Fault detection
  - Fault isolation
  - Fault characterization
  - Fault correction by control code reconfiguration or modification

Schematic diagram of a generic automated monitoring and commissioning process with self-correction



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Approach

- Build on accomplishments of an ongoing project with DOE
- Select HVAC subsystems and equipment for which to develop self correction
- Perform fault mode analysis
- Develop self-correction algorithms and supporting fault detection and isolation algorithms where needed
- Laboratory test the performance of the algorithms and study their sensitivity
- Refine and enhance the algorithms as indicated by testing, then retest