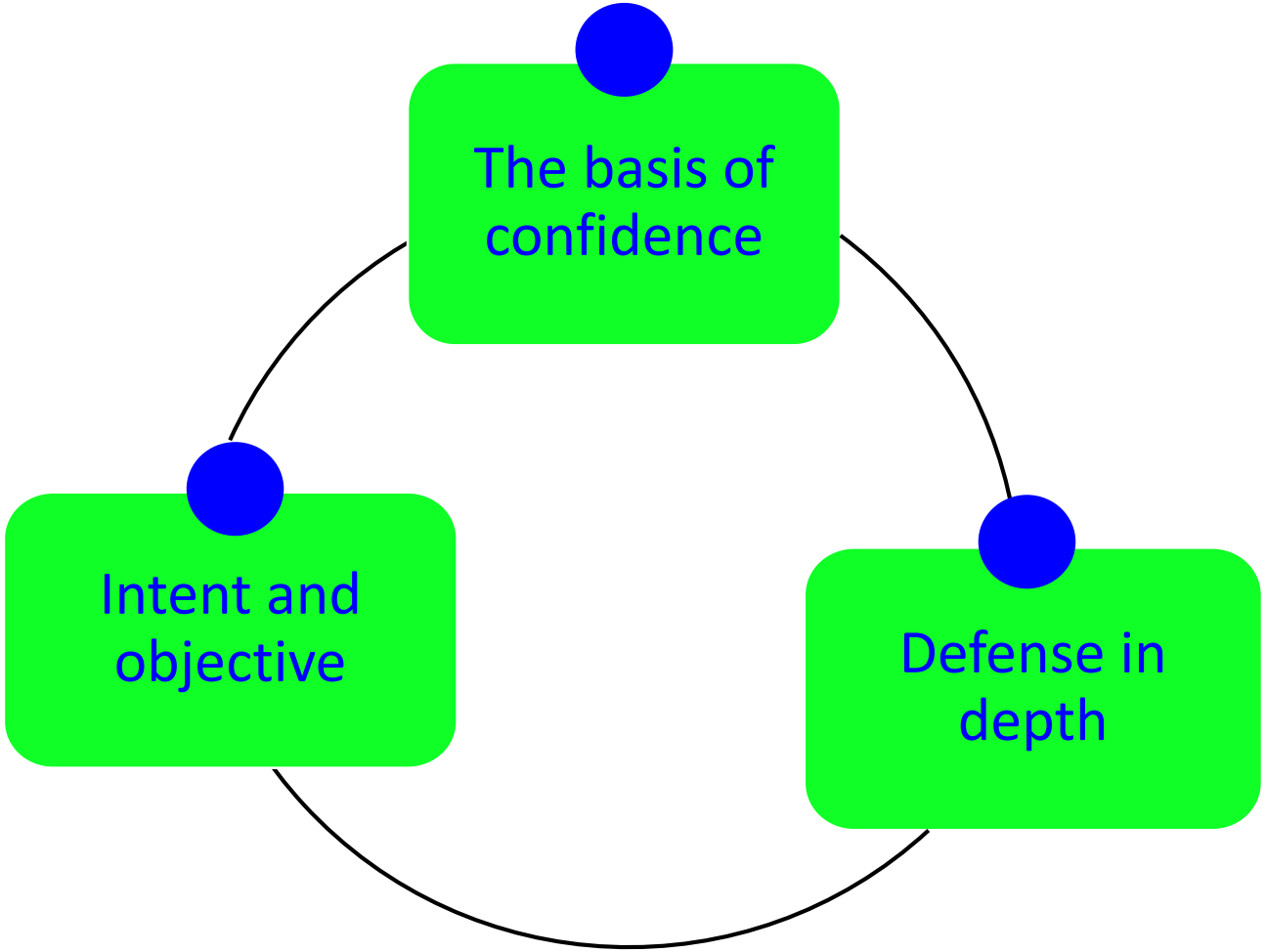
DYNAMIC POSITIONING CONFERENCE
OCTOBER 9-11, 2017

DESIGN

Independent Performance Validation for Robust and Resilient DP Systems

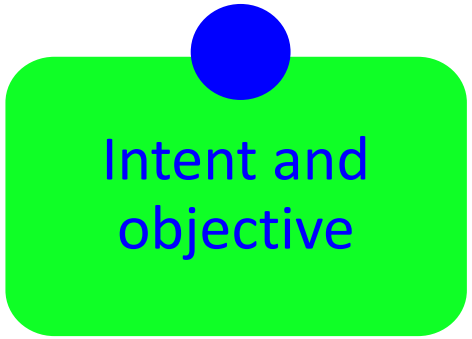
Steven Cargill
DNV GL Noble Denton Marine Services
Chunying Li
Aspin Kemp & Associats

The three pegs



Intent and objective

- **Intent**: Incident free DP operations
- **Objective:** A DP system which is:
  - Reliable
  - Robust
  - Resilient
- Reduce burden on crew and vessel time required to achieve objective

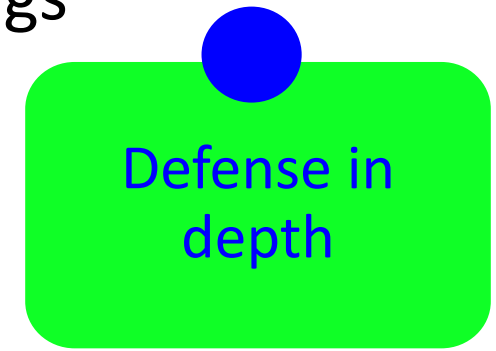


Basis of confidence

- Everything we do to give us reasonable confidence we will achieve our objective - includes many activities and processes:
  - Good vessel and DP system design
  - Fault tolerant DP systems
  - FMEAs and supporting studies
  - Crew competence
  - Develop procedures and decision support tools
  - Identification of the barriers to loss of position.

Defense in depth

- The process of maintaining the barriers
- All the things we do to check the barriers are intact:
  - Field arrival trials
  - Annual DP trials
  - Renewal trials
  - Planned maintenance
  - Gap analysis – new knowledge and learnings from incidents
  - Crew training
  - Inspection and survey



Station keeping integrity

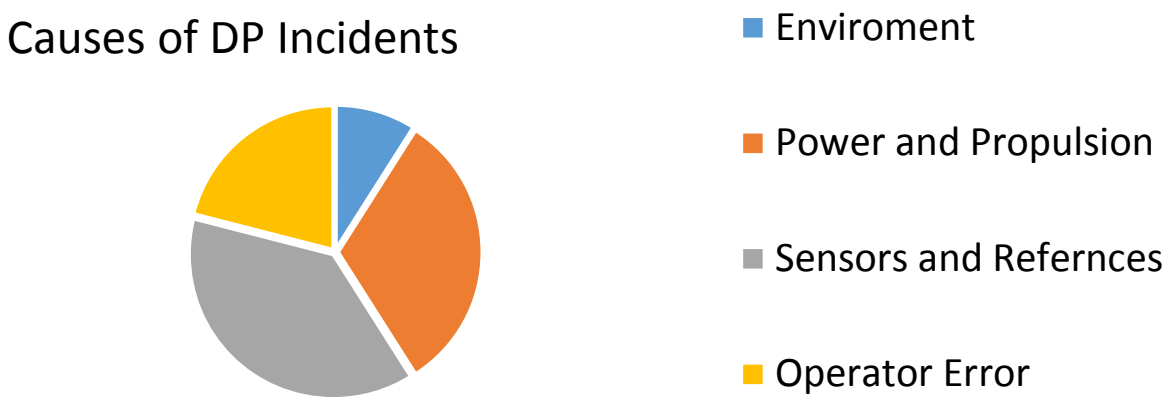
- *No single failure is to lead to a loss of position*
- Fault tolerant systems based on redundancy
- Hidden failures compromise redundancy
- System is only fully fault tolerant when intact
- Potential hidden failures include:
  - Deterioration in system performance
  - Defective protection systems and other dormant functions.
- Hidden failures must be detected.

Traditional verification processes

- Classification society rules and surveys during construction and in-service
- DP system FMEAs, proving trials and sea trials
- Field arrival trials
- Annual DP trials (continuous or batch)
- Planned maintenance activities
- Check lists.

DP Incidents

- DP loss of position incidents continue to occur
  - Many are not single point failures
- Single failure plus hidden failure
  - Surviving machinery unable to accept the load transfer
  - Protective functions did not work as expected
- Validation or verification issue



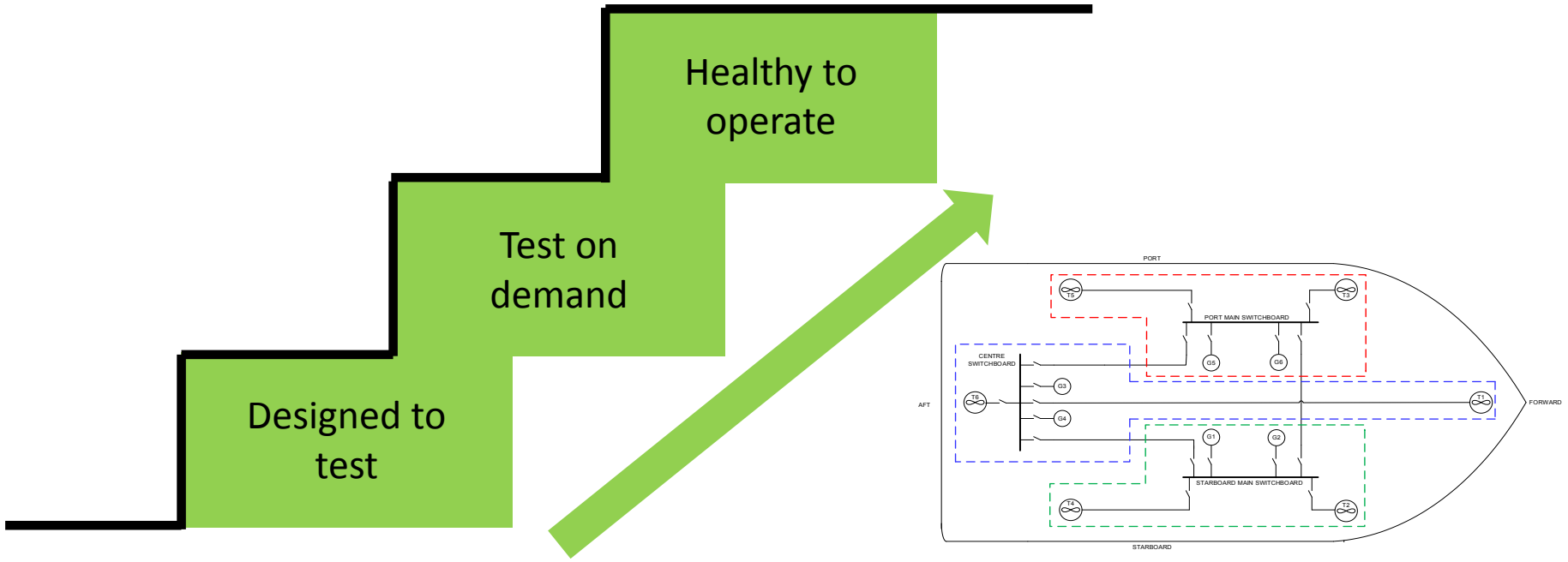
Still too many DP incidents

Independent Performance Validation

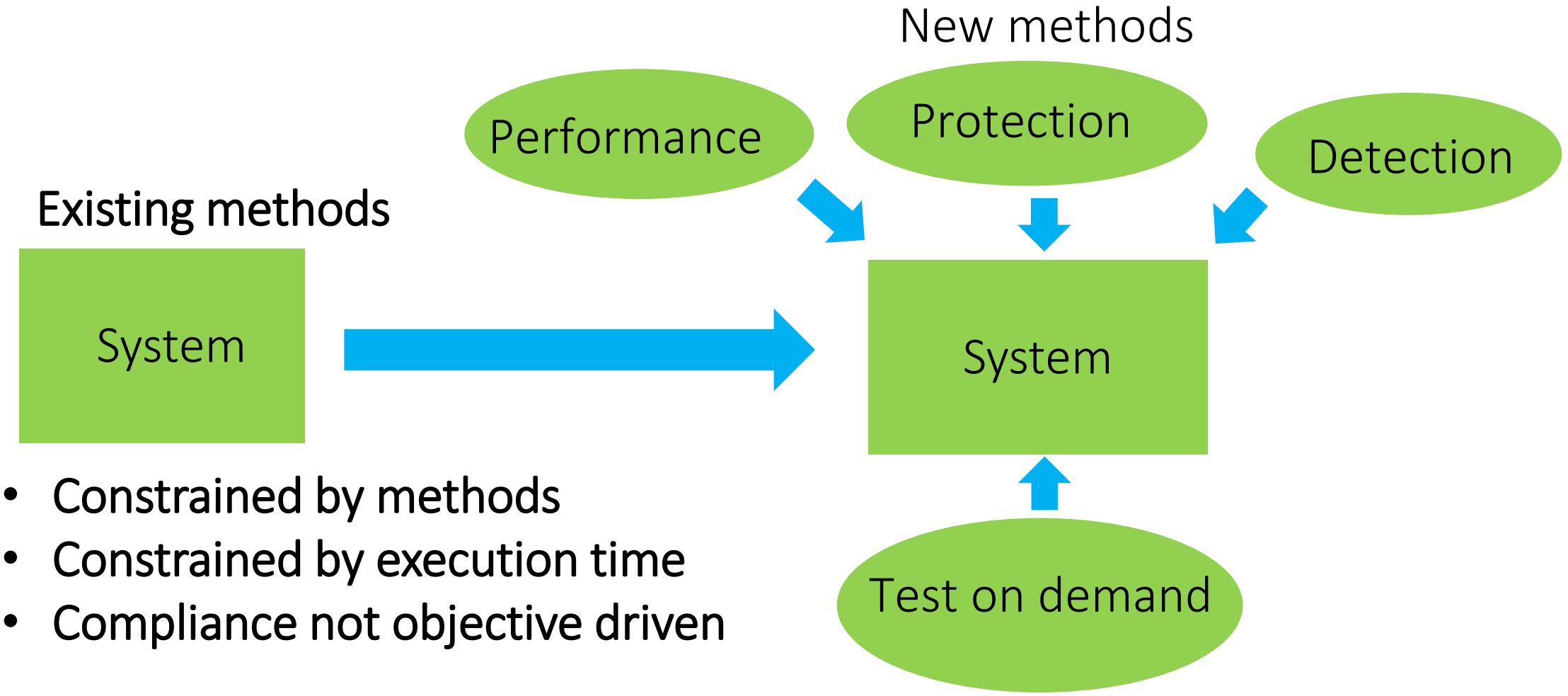
- Independent Performance Validation (IPV) is a ‘Principle’ that is outcome and objective driven.
- It is described as ‘independent’ because it is agnostic to the type of hardware, software and system provider to which it is applied.
- It is a form of ‘defense in depth’ that is used to validate and verify the barriers to loss of position in any DP system but can also be applied to other mission critical equipment.

In simple terms

- Know how the DP system works in detail
- Monitor and test its performance to build confidence and predictability
- Develop and test the barriers to loss of position.



Change in test objectives

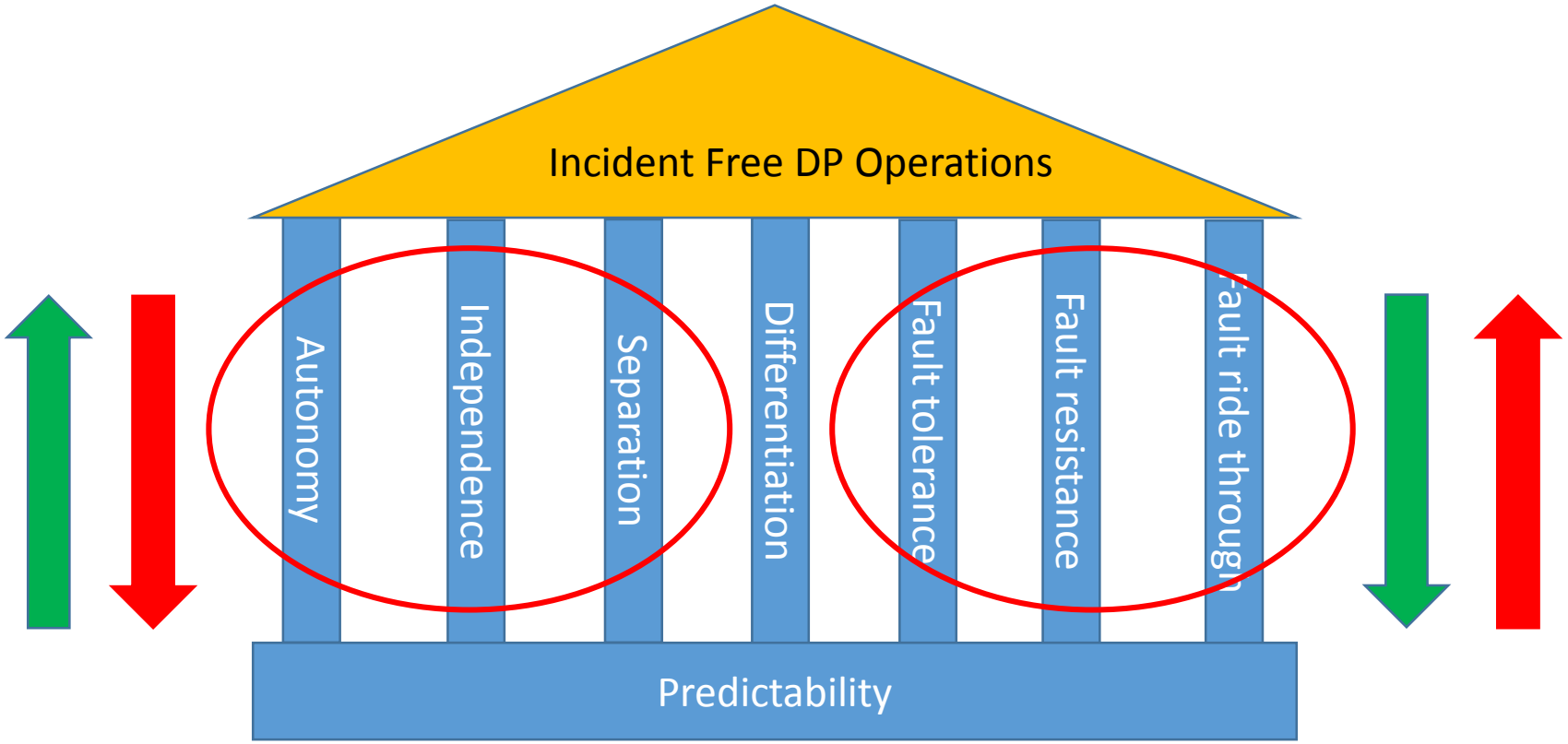


- Constrained by methods
- Constrained by execution time
- Compliance not objective driven

Low burden

- Objective: Reduce out-of-service time and improve DP system verification
- Combination of:
  - Condition monitoring with data analytics
  - Semi automatic testing – Easy and safe to execute.

Predictability through design validation



Seven pillars

Predictability through system verification

- Any verification process requires a:
  - Scope
  - Schedule
    - (schedule may be variable and controllable - condition & event driven)
  - What & Why
  - When

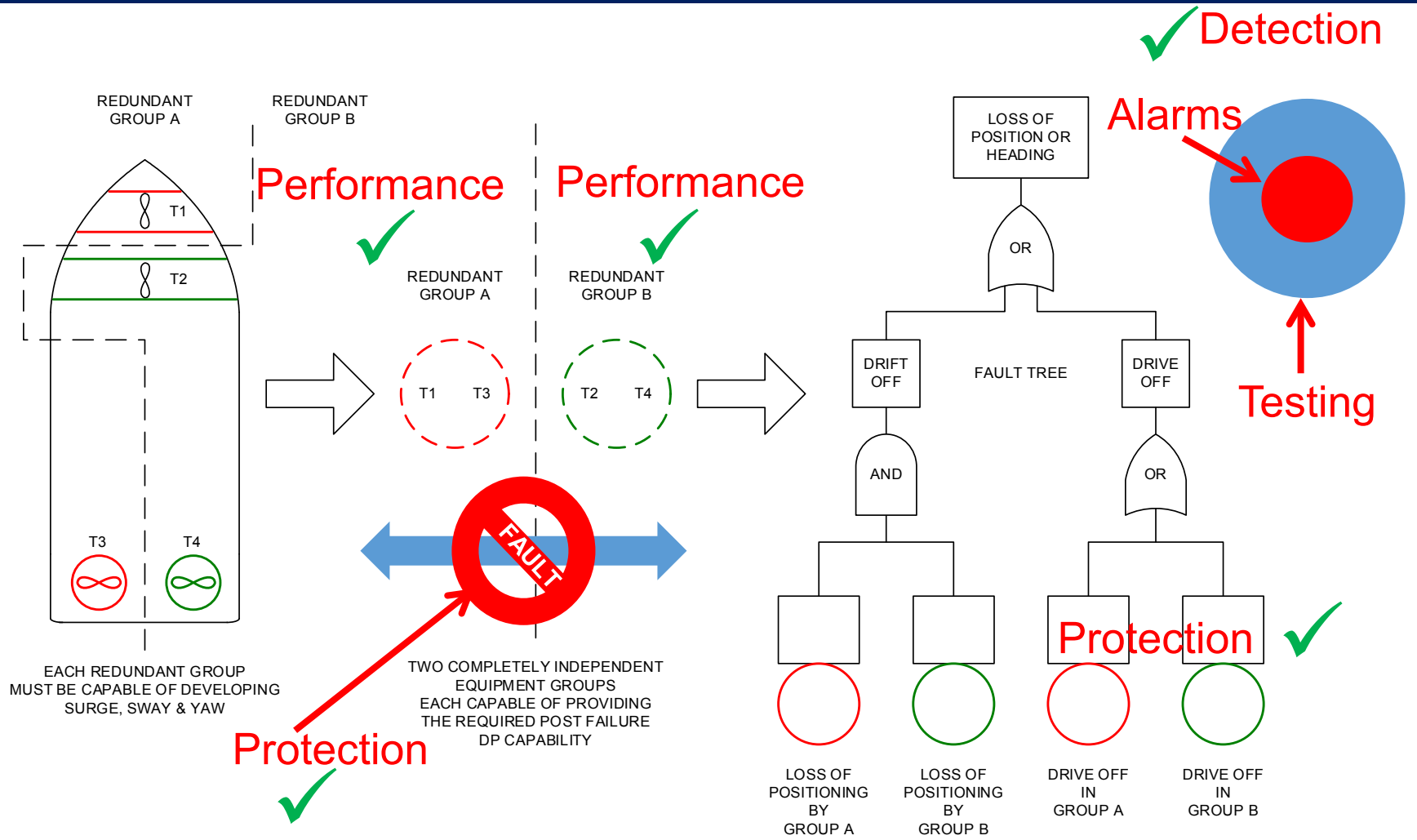
Identifying the verification scope

- Essential attributes in DP redundancy concept:
  - Performance attributes
  - Protective functions (including standby redundancy)
  - Alarms and indications required to initiate intervention.
- There may be many performance attributes that are useful indicators:
  - Static and dynamic capacity, power, load acceptance
  - Throughput, flow rate, differential pressure, temperature
  - Ride through
  - Error levels.
- What is the origin of the focus on performance and protection? – WHY?

Dynamic Positioning Committee
Marine Technology Society

Verification scope can be derived from FMEA

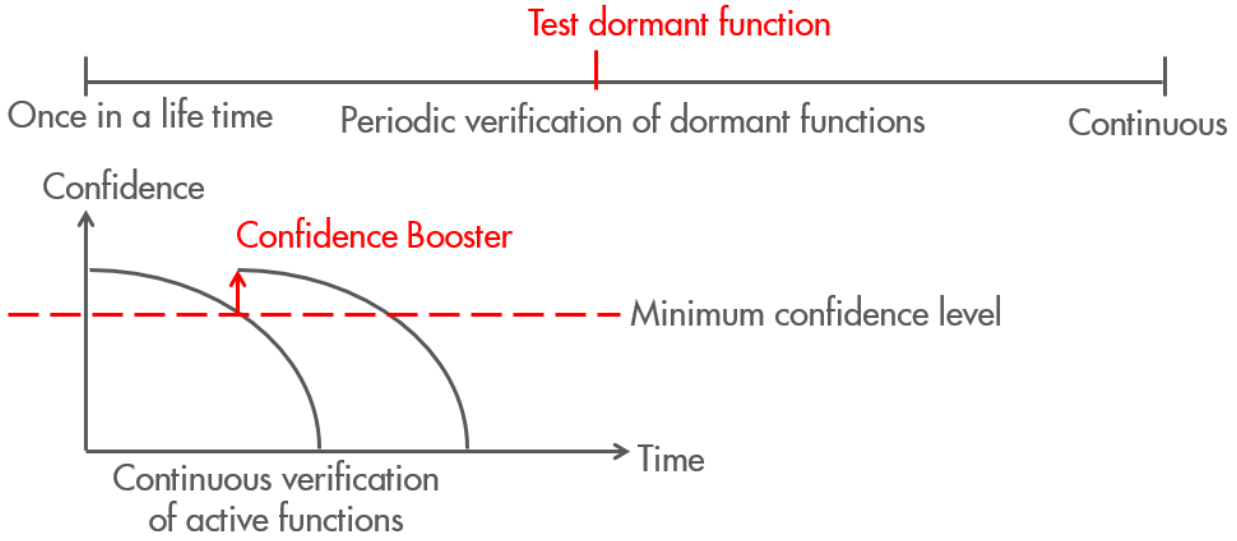
Essential attributes



Simple redundancy concept

Verification schedule

- Traditional verification methods defined schedule and constrained scope
- New methods confidence and event driven
- Must satisfy a number of stakeholders including manufacturers and classification societies.



Classification society initiatives

The major classification societies are consulting with industry stakeholders on how to enable remote verification for class DP surveys.

MORE

LESS

Practical examples

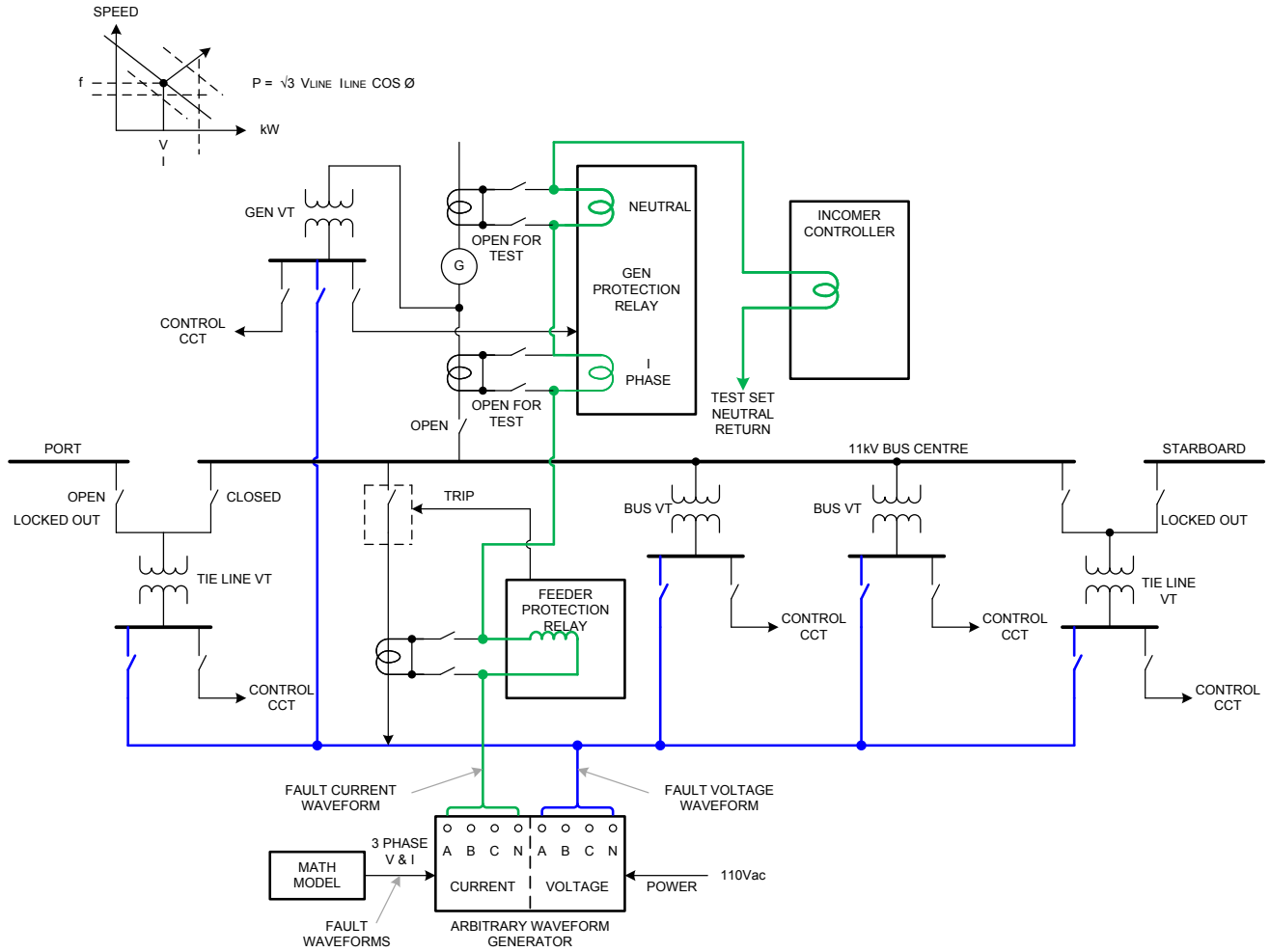
Verification of:

1. Protection for power plant operating with closed busties
2. Systems for blackout recovery
3. Parameters and software revisions in critical controllers.

Cascade waveform injection testing

- Testing the switchboard protection systems with three phase waveforms derived from time domain model of power plant
- ‘Cascade’ because all levels of protection can be tested in sequence
- Much wider range of simulated faults and plant configurations than is possible with live testing
- Explore limits and boundaries in a low stress environment
- Better than modelling alone – finds hardware issues and design flaws.

Principle of injection testing



Connections to switchboard

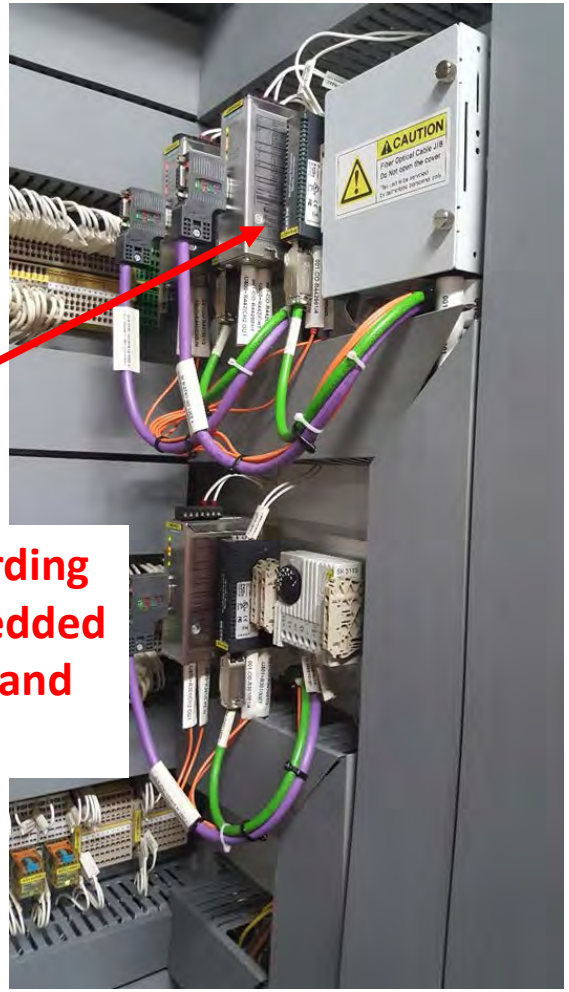
Waveform injection in practice

Production version

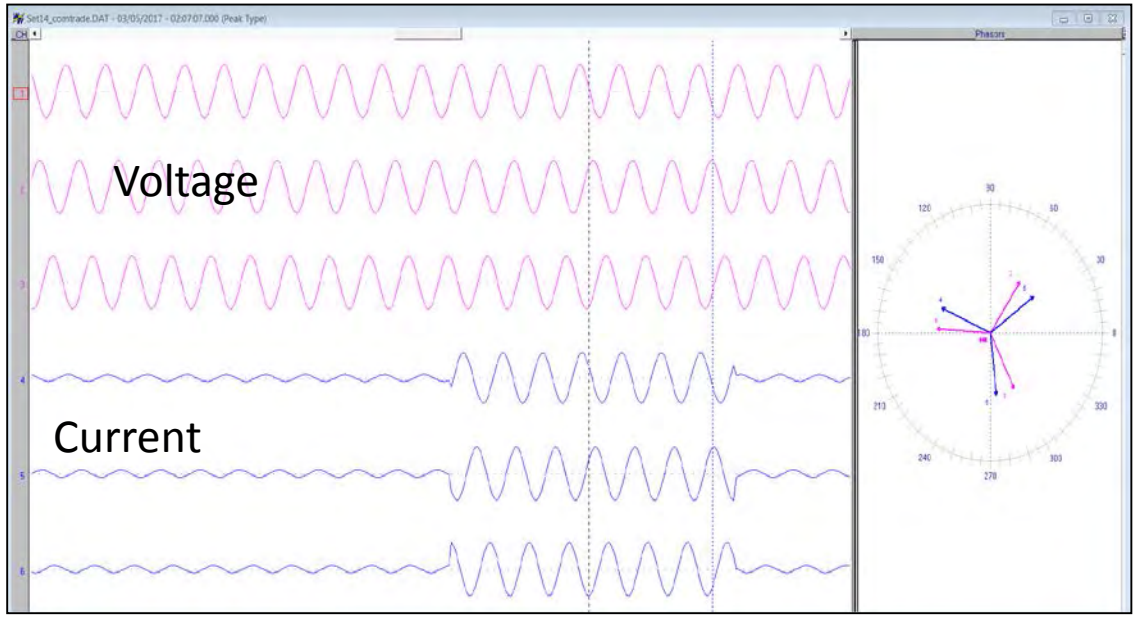
Data acquisition

Profibus sniffer

External test leads and recording equipment replaced by embedded highspeed data acquisition and logging equipment

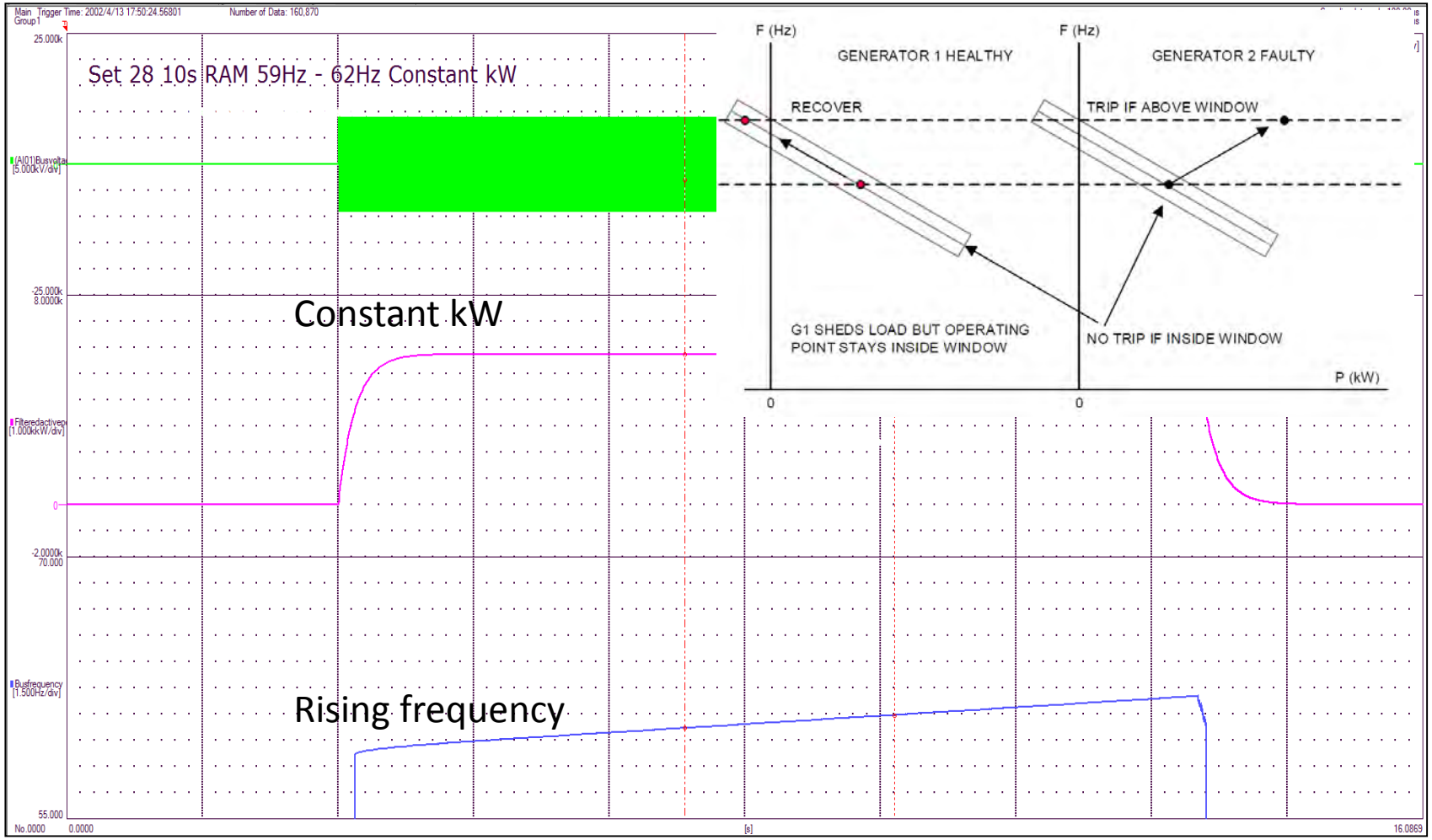


Waveform generator



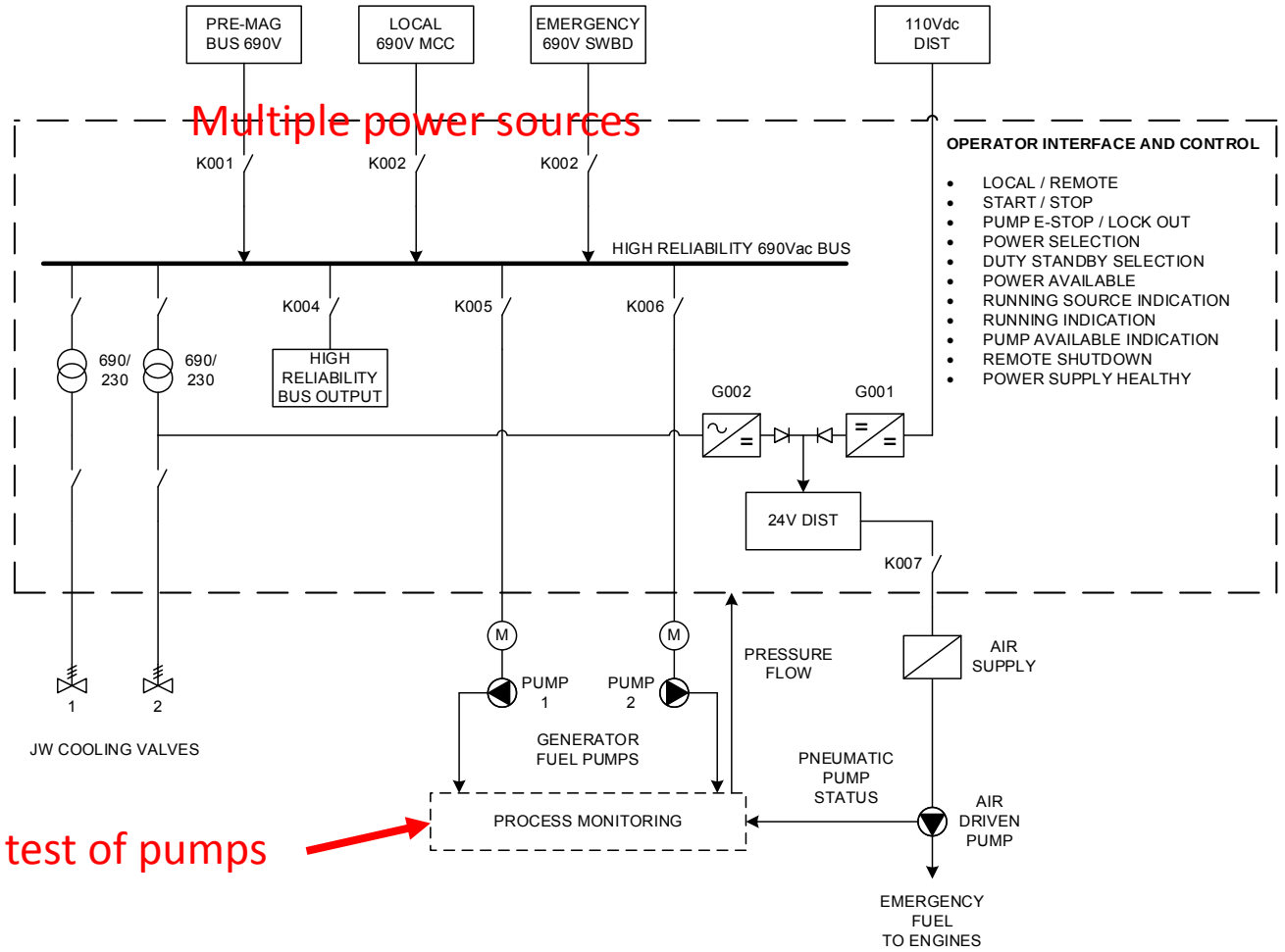
- Multichannel arbitrary waveform generator interfaced to switchboard through harness
- Simulating a high current fault

Testing protection response



Governor fails to full fuel

High reliability in blackout recovery



Periodic automatic test of pumps

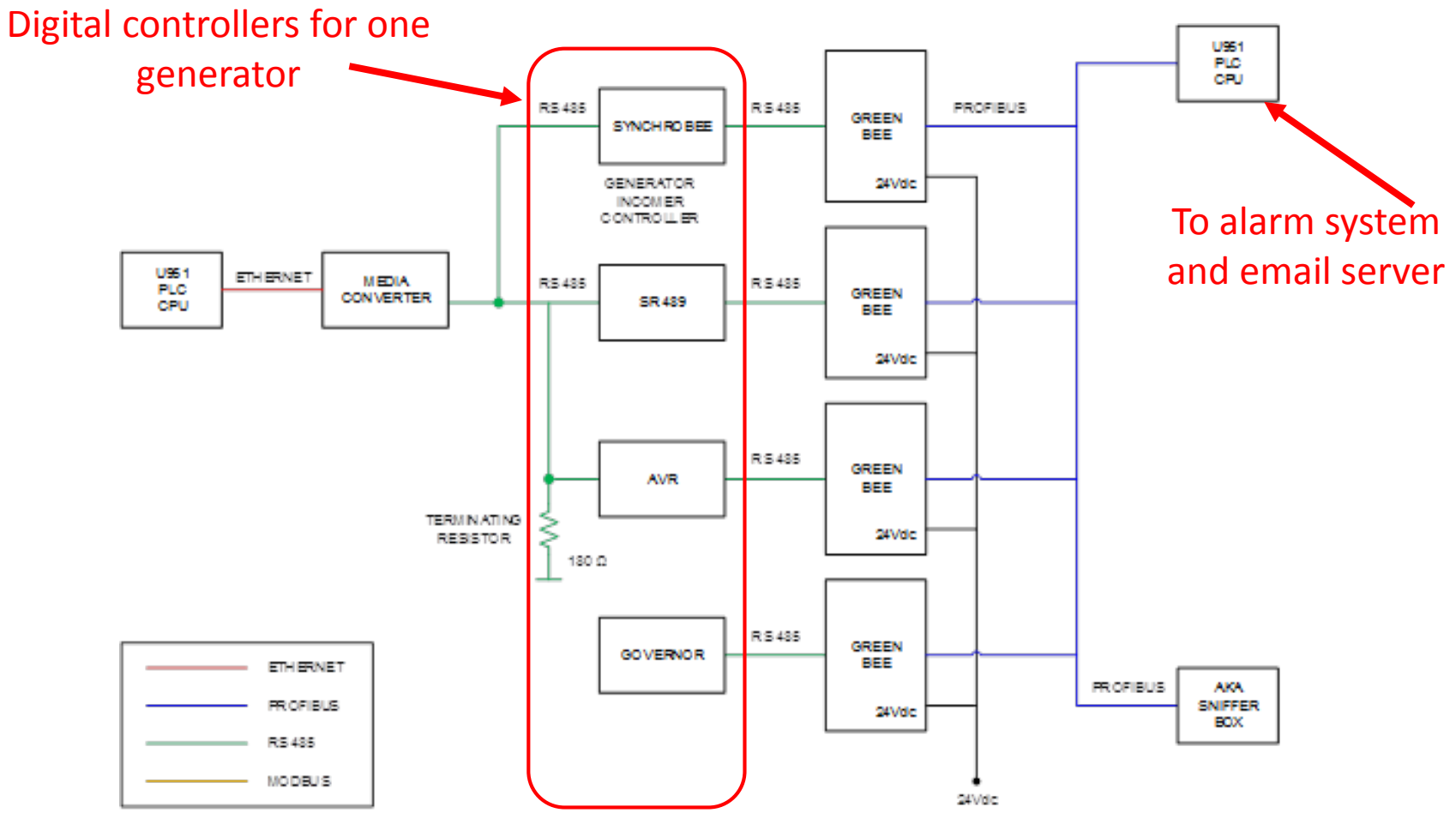
Monitoring of other dormant functions

User configurable settings

Monitoring parameters and access to digital controllers

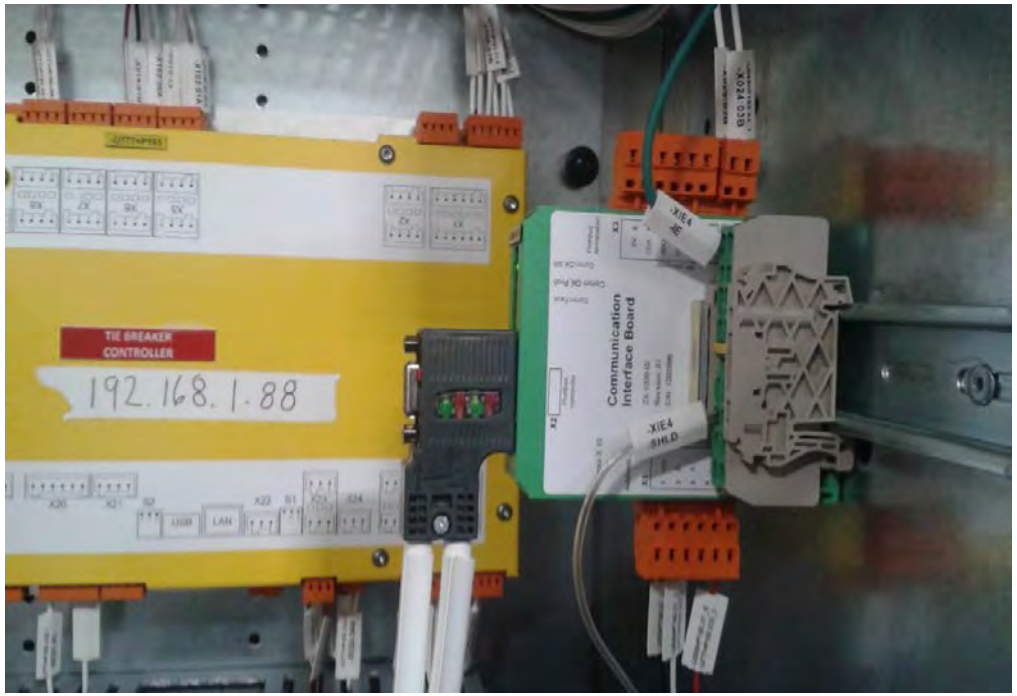
- Parameters affect performance (also SW Rev)
- Wrong parameters continue to cause DP incidents
- Parameters get changed inadvertently

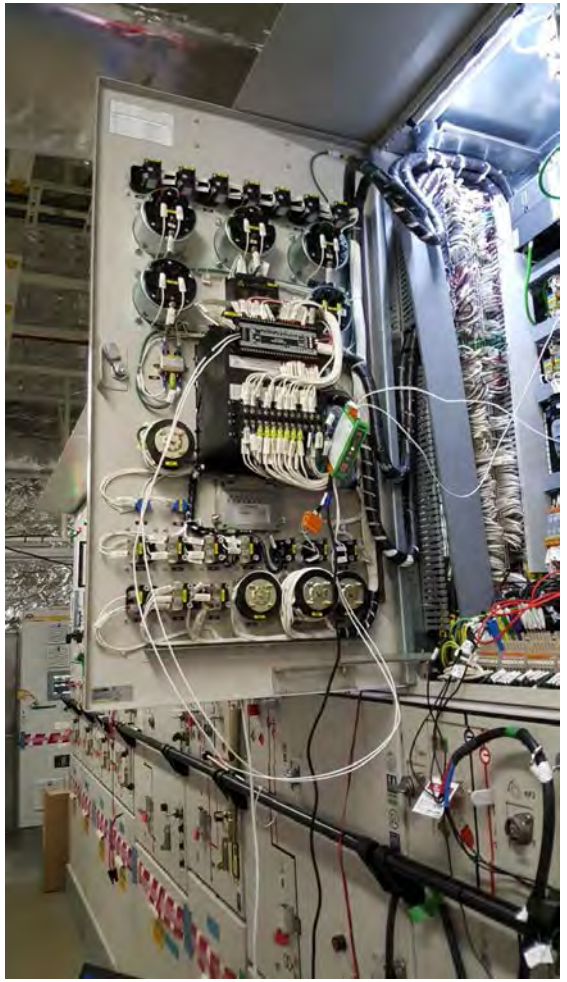
Monitoring of parameters



Monitoring access, parameters and revisions

- Green Bee gathering data from generator protection relay
- Yellow Bee and Green Bee





Conclusions

- IPV is a principle not a product
- It can be applied to any system but is a good fit to DP system designs built to the seven pillars
- It is intended to provide superior DP system integrity
- It is intended to be more time efficient than traditional verification methods.

Thank you

steven.cargill@dnvgl.com

CHUNYINGLI@aka-group.com