

Session Session 8a: System Oscillations

A Guide to Oscillations



ESIG

ENERGY SYSTEMS
INTEGRATION GROUP

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2024 ESIG SPRING WORKSHOP

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- **Why are we here?**

- A growing litany of (scary) oscillations, many of which are (or seem to be) correlated to the rise of IBRs

- **What is new and different?**

- Less physics (in the sense of behavior linked to material reality of equipments)
- More control (in that the brains, or lack thereof, of fast acting devices is at the core of the observed behaviors)
- Not everything! (We aren't 100% IBR; the “old” dynamics are still critically important)

A call from the industry for HELP!

Diagnosis and Mitigation of Observed Oscillations in IBR- Dominant Power Systems



A Practical Guide
ESIG Stability Task Force

Beta Version:
Spring WS 2024



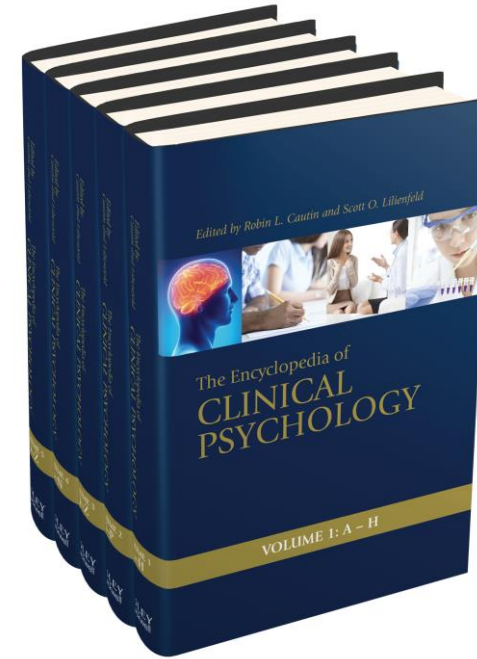
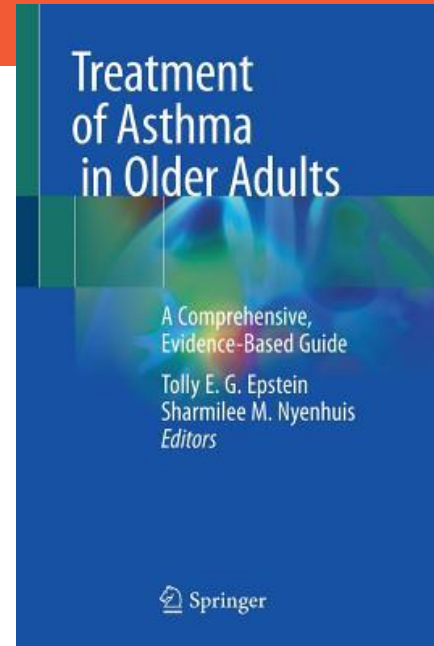
Diagnosis and Mitigation of
Observed Oscillations in IBR-
Dominant Power Systems:
A Practical Guide



Who will use this guide? Moderately experienced system planners.

- i.e. people who regularly perform dynamic analysis (e.g. phasor stability work, EMT work) for ISOs, RTOs, TOs, Asset owners, developers.
- But who may not have extensive experience with integration of IBRs
- Experienced system operator engineering staffs.
 - i.e. people who will be in the line of fire when reports/measurements of oscillations (grid, otherwise) come in (after something whacky happens in the field).
 - Engineering support thereof. People who will be charged with **“what the heck is this, and what do we do about it?”**

This is what we aimed for:



This

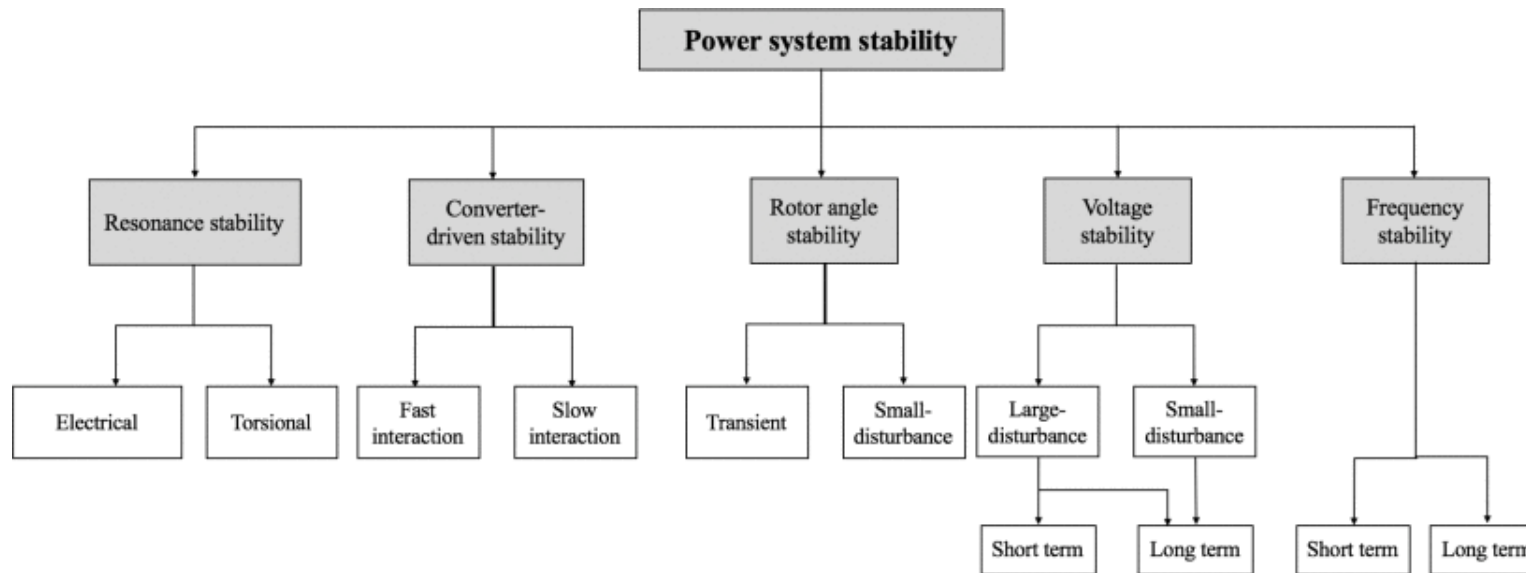
Maybe a
bit of this

Definitely
not this

We engage the user as “diagnostician” in the guide

Taxonomy isn't as obvious as you might think

IEEE Stability hierarchy is not ideal for diagnosis
focused on oscillations



We adopted a somewhat different hierarchy:

- SSO
- Voltage
- Angle/ Transient Stability
- Frequency
- Harmonics

source

N. Hatziaargyriou *et al.*, "Definition and Classification of Power System Stability – Revisited & Extended," in *IEEE Transactions on Power Systems*, vol. 36, no. 4, pp. 3271-3281, July 2021, doi: 10.1109/TPWRS.2020.3041774.

Elements of a Practical Guide



Observations

- Field measurements vs. simulations?

Simulation credibility

- Do you trust the simulations?

Initial Assessment (what might this be?)

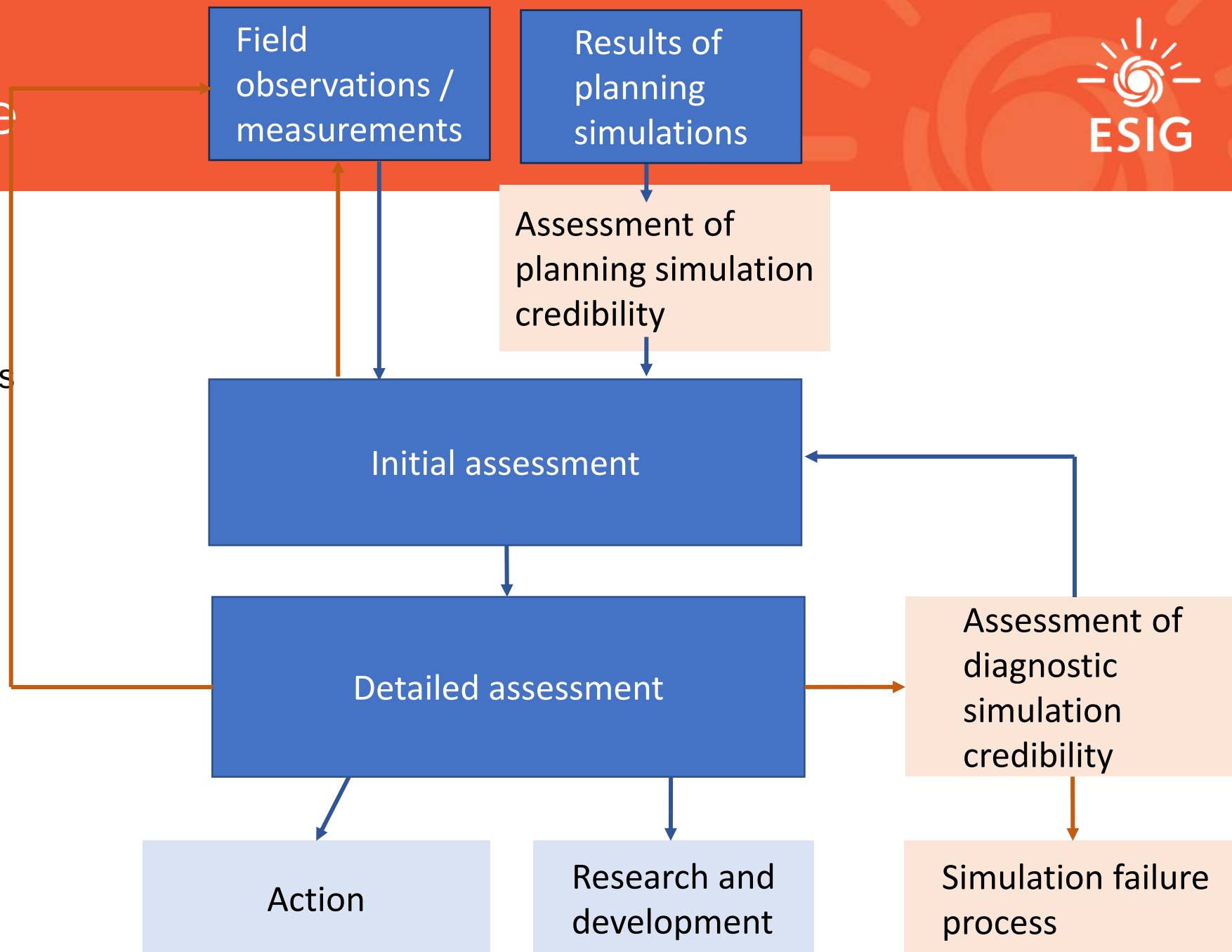
- Do you have the right information/measurements?
- What do you look for initially?
- Initial Assessment
 - ID suspected causality for detailed assessment (or get more data)

Detailed Assessment

- Discussion of phenomenon;
- Explanation of the screening matrix
- Techniques for performing analysis
- What we don't know/gaps: R&D needed)

Countermeasures

- Is mitigation needed?
- Various techniques mitigation (what specifically is needed?)



Elements in the Guide



Introduction

Oscillations and System Stability

- IEEE Stability Definitions

- Forced Oscillations and Systemic Poor Damping

Basics of Identification Diagnostics

- Field Measurements and Observations

- Measurement Quality

- Signal Processing

Initial Assessment

- General Discussion of Analytical Tools and Approaches

- Tools Overview

- Simulation Credibility

Detailed Assessment and Countermeasures

- Latency

- Subsynchronous and Supersynchronous Oscillations (SSO)

- Voltage Control Induced Oscillations

- Transient/synchronization Stability Induced Oscillations

- Frequency or Active Power Control Induced Oscillations

- Harmonic Oscillations

Simulation Failures

- Closure

References

Initial Assessment

Field observations /
measurements



No

Screening questions

Selection of likely
cause(s)

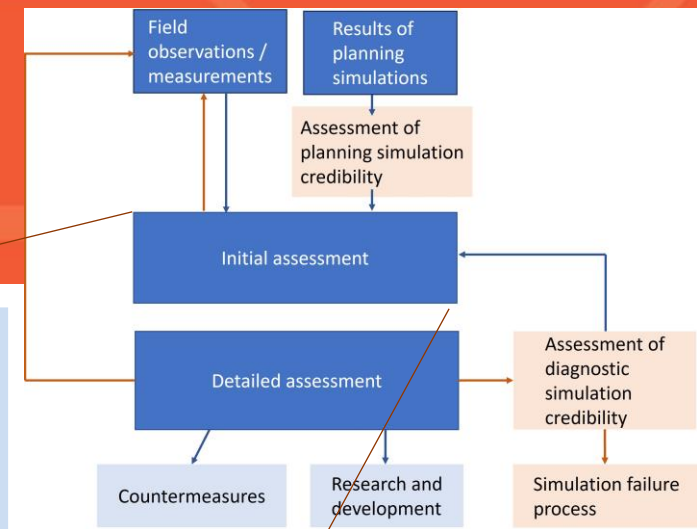
Detailed assessment

Yes

Simulation check
questions

Simulation is
not credible

Simulation failure
process



What seems to be
happening, and what
appears to be
participating?

Screening Matrix: An aid for “Likely Causes”



Strong Positive Indicator

Weak Positive Indicator

Neutral Indicator

Weak Contraindicator

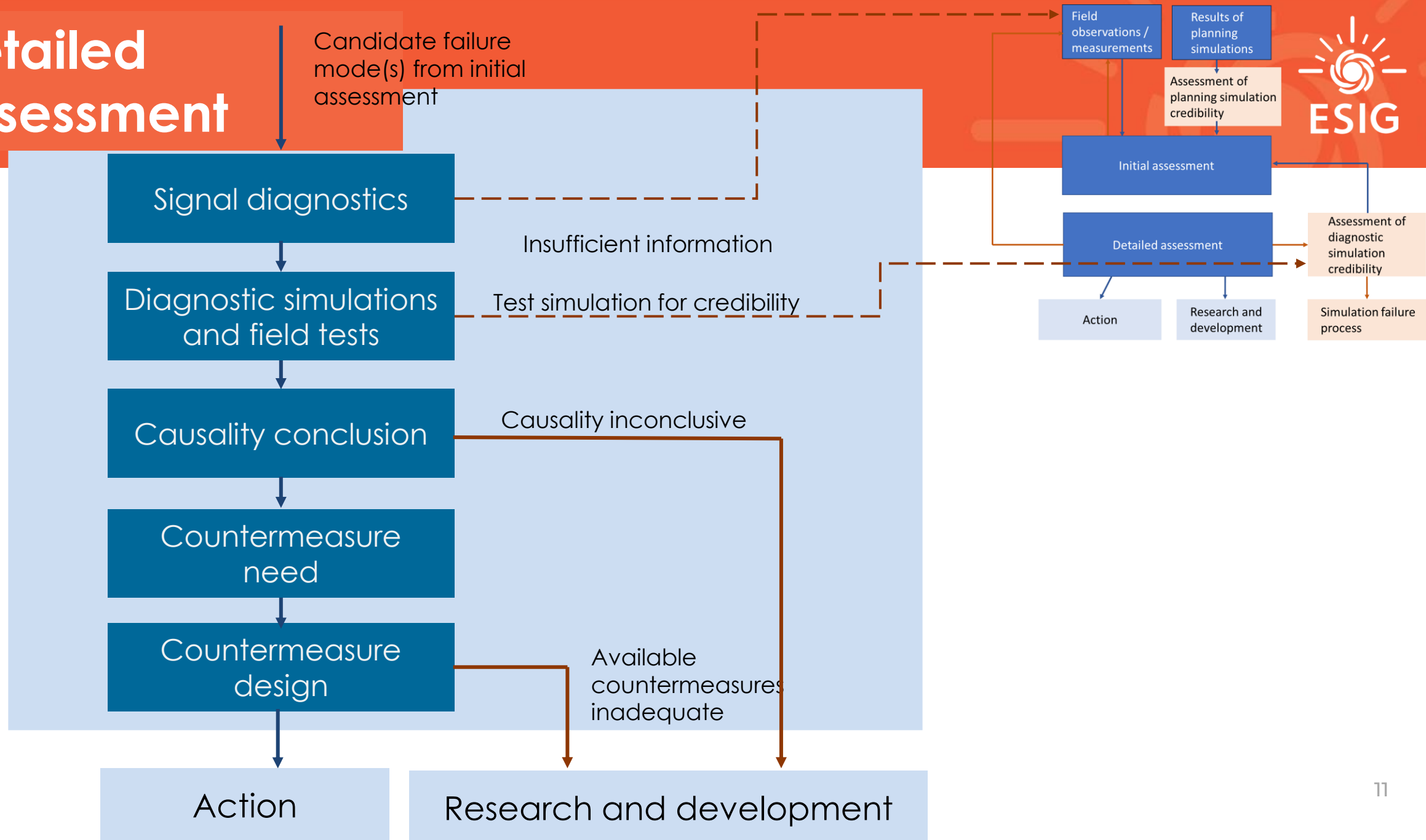
Contraindicator

Causality/Failure Mode

[illegible]

Characteristics (Question Answers)

Detailed Assessment



-
1. With HVDC (well understood)
2. With (multiple) IBRs (less understood)
- Host AC System
- Series Compensation
- Generator Rotor
- Stator Winding
- Air Gap
- V_g
- I_g
- T_e
- ω_G
- Bulk System
- F_0 (60Hz)
- F
- Z
- Voltage
- IBR
- IBR
- IBR
- X
- HVDC

- State Space Methods
- Static Frequency Scan Methods
- Dynamic Model Network Frequency Scans
- Static Power Frequency Tools
- Methods for Locating the Source of Oscillations
- Time Domain Simulation with Sequence/Phasor-based Tools
- Time Domain Simulation with 3 phase, Point-on-wave Tools
- Hybrid Tools
- Tools Applicability

What's Next



A final draft is available for review.

We will be taking notes during the special workshop tomorrow

We are accepting comments for about 3 more weeks. (see feedback in draft guide)

We will finalize, i.e.

- Incorporate final inputs

- Edit for clarity, syntax

- Finalize attributions, permissions, figure quality

Release to public

- Rollout details TBD.

Thanks



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