CIGRE Study Committee C2

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG[1] C2/B5.46	**Name of Convenor:** Emil Hillberg (SWEDEN)
Strategic Directions #[2]: 1,2,3	**Sustainable Development Goal #[3]:** 7,9

This Working Group addresses these Energy Transition topics:

- [ ] **Storage**
- [ ] **Hydrogen**
- [ ] **Digitalization**
- [ ] **Sustainability and Climate Change**
- [X] **Grids and Flexibility**
- [ ] **Solar PV and Wind**
- [ ] **Consumers, Prosumers and Electrical Vehicles**
- [ ] **Sector Integration**
- [ ] **None of them**

Potential Benefit of WG work #[4] : 1,4,5

Title of the Group: System Integrity Protection Schemes and the (N-1) criteria

Scope, deliverables and proposed time schedule of the WG:

Background:

Over the last decade, significant and fast increase of Decentralized Energy Resources (DER) and Inverter Based Generation (IBG) have been observed in many countries to facilitate the integration and transmission of renewable energy (e.g., solar and wind farms, HVDC links, etc.). It becomes more and more obvious that this (r)evolution will go on in the foreseeable future and will probably accelerate due to the urgent need for decarbonization and the decision made by some countries to leave the nuclear technology in relatively short term.

At the same time, most utilities struggle to build fast enough the new infrastructure needed to support all these evolutions, mainly due to the intrinsic time needed to realize investment projects, the difficulties to get permits on time and the increasing stress on electrical equipment supply chain as a result of the on-going electrification wave. Accordingly, grid reinforcements are usually optimized through risk-based approaches in order to enhance as much as possible the overall grid capacity while limiting the number of new interconnections or substations to deploy.

All those combined elements will probably lead to:

- changes in power system dynamic behaviours (less inertia, different DER and IBG responses than synchronous generation, variable power flows …)
- less stability margins as the system will be exploited closer to its limits
- more severe impact for specific system disturbances

The interest in utilizing automatic control schemes is increasing internationally to enable TSOs to provide adequate and secure grid capacities in an agile manner. Such automatic schemes are commonly referred to as System Protection Schemes, Special Protection Schemes, Remedial Action Schemes, or by the broader term: System Integrity Protection Schemes (SIPS).

SIPS serves to enhance security and prevent propagation of disturbances for severe system emergencies caused by unacceptable operating conditions and is used to stabilize the power system by taking control action to mitigate those system conditions. It also encompasses Special Protection Systems and Remedial Action Schemes as well as underfrequency, undervoltage, and out-of-step protection schemes. [IEEE Std C37.250-2020]

As proposed by [Stanković 2022], each SIPS should be able to be defined by its goal, objective, and means, as:

- Goal: Increase the power system reliability and/or capacity.
- Objective: Prevent degradation of the power system technical performance (regarding stability and/or overloading phenomena) in cases with non-secure pre-contingency state or extreme contingencies.
- Means: Using selected, automatic, mitigative actions.

Nowadays, the most usual application of SIPS is to preserve system integrity in case of extreme and exceptional events, such as corridor loss during severe storm, for example. However, they could also be used to counteract any (N-1) incident and accordingly to free up grid capacity in N situation. This would imply a need to review operational reliability policies and might require a distinction between these two types of SIPS objectives. The use of both these types of SIPS can significantly influence the provision of transfer capacity in the grid for various situations, and makes it important to identify and mitigate risks related to the increased dependencies on SIPS in operation.

Research proposing novel SIPS, together with Wide-Area Monitoring Protection and Control (WAMPAC) solutions are important to take the necessary steps for the future power system, described in CIGRE TB 917. However, the criticality of these type of systems makes it equally or even more important to take steps toward standardisation and thus stressing the need to gather learnings from already implemented solutions together with a common understanding of requirements for implementation of new solutions.

Purpose/Objective/Benefit of this work:

The objective of this WG is to contribute to an increased understanding of SIPS, their value and opportunities and their impact on the secure operation of the power system, including learning from experience and sharing knowledge regarding design and operation of SIPS in different power systems.

The work in this WG, will build on earlier efforts such as the ones listed below, with the focus on addressing the status of implementation of SIPS around the world today, and how SIPS are foreseen to become further integrated in todays and tomorrow's power system.

Scope:

This working group will focus on learnings from implemented SIPS and requirements on implementation of new SIPS and does not intend to focus on proposals of novel SIPS solutions from research.

The working group would investigate and report on:

1. Revisiting the definitions of SIPS (is it possible to describe various SPS/RAS/SIPS solutions under a single umbrella?) including clarification of differentiation/terminology between SIPS used to increase grid capacity in N situation and SIPS aimed at counteracting exceptional and extreme events.
2. Common practice and recommendations for SIPS design, with a clear distinction between:
   - The identification of the desired SIPS response by system stability experts (which type of event to detect? Which action to undertake? How fast? Expected SIPS availability? …)

- The SIPS implementation by protection, automation and control experts in order to fulfil the identified system needs (architecture, redundancy, event detection process, decision logic, telecommunication protocols, interface with usual Protection Automation and Control Systems …), with a special attention to cyber security considerations

3. Factory acceptance tests and commissioning, Maintenance and SIPS evolution:
   - Insourcing/outsourcing of SIPS maintenance? Maintenance policy and test procedures?
   - Knowledge management and documentation: drawings, manual for operators …
   - Adaptation of existing SIPS depending on power system evolution
4. Operational management
   - Interfaces and visualisation in the control room for Operators' situational awareness
   - Manual and automatic interaction between human, SIPS, and other systems in the control room and in the substation
5. International examples and experiences (including quantified examples of usage, costs, and benefits)
6. Assessment of SIPS drawbacks and risks
7. Future forecasted needs, and requirements/questions for further research

Remarks:

Relevant previous related activities which the work of this WG will be based on include:

- CIGRE TB 128, Protection Against Voltage Collapse, 1998
- CIGRE TB 187, System Protection Schemes in Power Networks – 2001
- CIGRE TB 316, Defence Plan Against Extreme Contingencies, 2007
- CIGRE TB 325, Review of Online Dynamic Security Assessment Tools and Techniques, 2007
- IEEE PSRC Report -8-19-2009, Industry Experiences With System Integrity Protection Schemes (SIPS), 2009
- CIGRE TB 664, Wide area protection & Control technologies, 2016
- CIGRE TB 750, WAMS, Support for control room applications, 2018
- IEEE Std C37.250, IEEE Guide for Engineering, Implementation and Management of System Integrity Protection Schemes, 2020
- CIGRE B5 Tutorial on SIPS, Paris 2022
- Stanković, Hillberg, Ackeby, "System Integrity Protection Schemes: Naming Conventions and the Need for Standardization", Energies 2022, 15
- CIGRE TB 917, Wide Area Monitoring Protection and Control Systems - Decision Support for System Operators, 2023

Deliverables:

☒ Annual Progress and Activity Report to Study Committee
☒ Technical Brochure and Executive Summary in Electra
☐ Electra Report
☐ Future Connections
☒ CIGRE Science & Engineering (CSE) Journal
☒ Tutorial
☒ Webinar

Time Schedule:

- Recruit members (National Committees, WiE, NGN) Qtr 3 2024
- Develop final work plan Qtr 4 2024

• Draft TB for Study Committee Review • Final TB • Tutorial • Webinar	Qtr 2 2027 Qtr 4 2027 Qtr 3 2028 Qtr 2 2028
Approval by Technical Council Chair: **Date**: June 6th, 2024	[signature]

Notes:
[1] Working Group (WG) or Joint WG (JWG),
[2] See attached Table 1,
[3]See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work.
[4] See attached Table 3

WG Membership: refer Comments at end of document

Table 1: Strategic directions of the Technical Council

1	The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.

Comments:

1) CIGRE Official Study Committee Rules: WG Membership

https://www.cigre.org/GB/about/official-documents

a. Only one member per country: by exception of SC Chair, WiE and NGN nominees.

b. WG nominees by NCs must first be supported by their National Committee (or local SC Member) as an appropriate representative of their country.

c. Acceptance of the nomination is granted by the SC Chair and advised to the WG Convener.

2) Collaboration Space

https://www.cigre.org/article/GB/collaborative-tools-2

CIGRE will provision the WG with a dedicated Knowledge Management System Space.

The WG will use the KMS for drafting collaboration, capture and retention of discussion and meeting records.

Official country WG Members will be sent registration instructions by the Convener.

Official country WG Members may request the WG Convener to allow additional access for an extra national subject matter specialist to aid in the work at the national level, including NGN members.