Deliverable 3.1
Procedures for KPIs calculation

	Name	Date
Prepared by:	Renato Girelli	14.11.2024
Checked by:	Renato Girelli	22.01.2025
Approved by:	Silvio Reali	31.03.2025

Project co-funded by the Research Fund for Coal and Steel (RFCS)

G.A. 101112102

Project details

Project Name	**Remote expert virtual system enhancing human management capabilities and favors preservation, transfer and continuous evolution of knowledge for steelmaking operation**		
Project Acronym	iSteel-Expert		
Project No.	101112102	Duration	36 months
Project Start Date	01.07.2023	Project End Date	30.06.2026

Document details

WP:	**3**	**WP Leader:**	**SSSA**
WP Title:	Detailed procedures for KPI calculation, events identification and solutions implementation		
Task:	3.2	Task Leader:	TENOVA
Task Title:	Implementation of basic logics for event detection and implementation/suggestion of corrective actions based on KPIs		
Deliverable No.	3.1		
Deliverable Title	Procedures for KPIs calculation		
Dissemination level	PU		
Written By	TENOVA		
Contributing beneficiary(ies)	ALL		
Approved by	ALL		
Status	Revision 1.1		
Date	22.01.2025		

Document history

Vers	**DATE**	**AUTHOR / REVIEWER**	**NOTES**
1.0	14.11.2024	Renato Girelli	Preparation of initial version
1.1	22.01.2025	Renato Girelli	Review and update

Index

1. Introduction

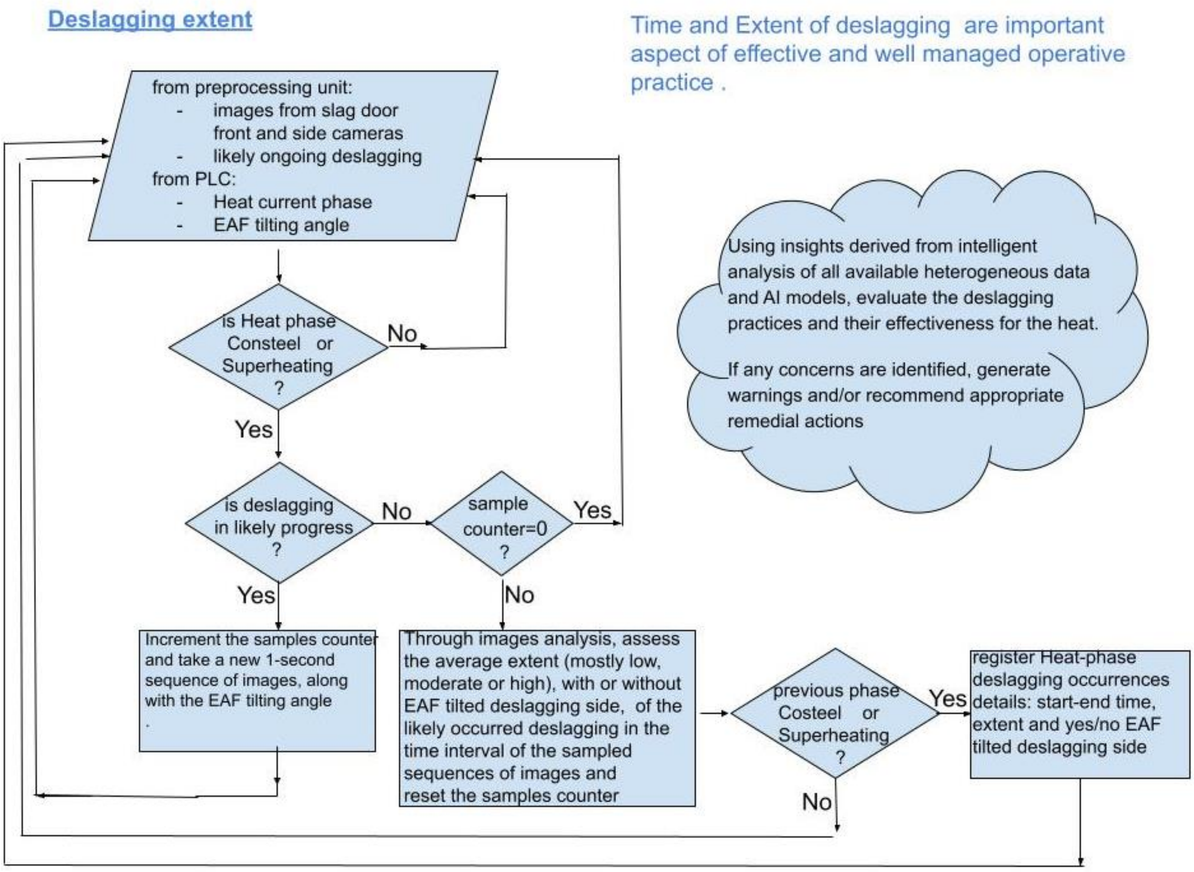
This document is concerned with the flowcharts of the procedures to be implemented for the detection of relevant events and the proposed corrective actions. The simple solution represented by these basic procedures will then be overcome by more advanced data fusion strategies (e.g., using artificial intelligence), more sophisticated and human-like decision strategies (e.g., using fuzzy logic instead of standard logic), and sensitive parameters to be fine-tuned by advanced optimization approaches (e.g., those based on evolutionary computation) once data from the first system test campaign tests become available.

2. Procedures - monitored events and conditions - suggested actions

In the next chapters the flow charts of the procedures, their monitoring objectives and the corrective actions they should suggest against the detection of poor process condition or equipment malfunction.

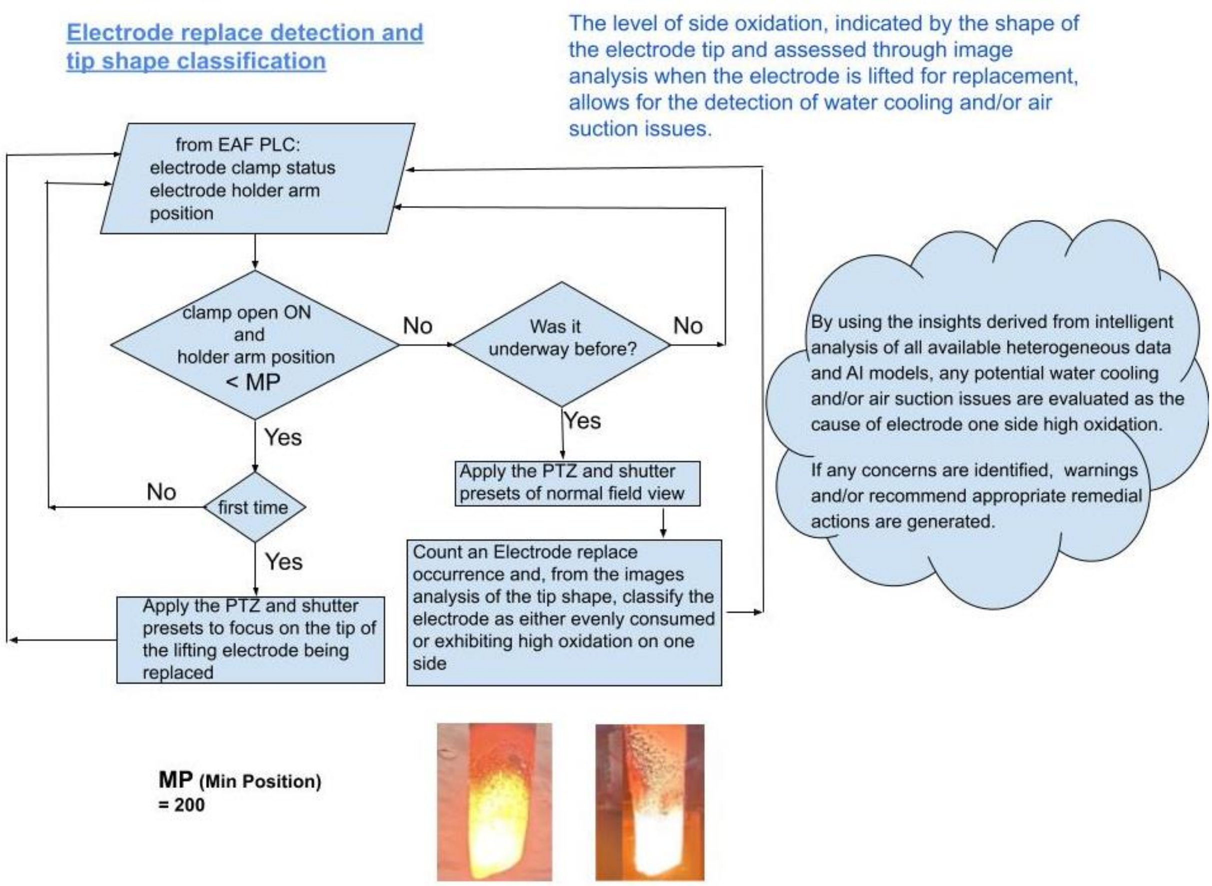
2.1 Deslagging Extent

Time and extent of deslagging are important aspect of effective and well managed operative practice. Frequent and lasting deslagging are index of not well managed operative practice: manual improvement of deslagging control and operator compliance are the corrective actions to suggest.



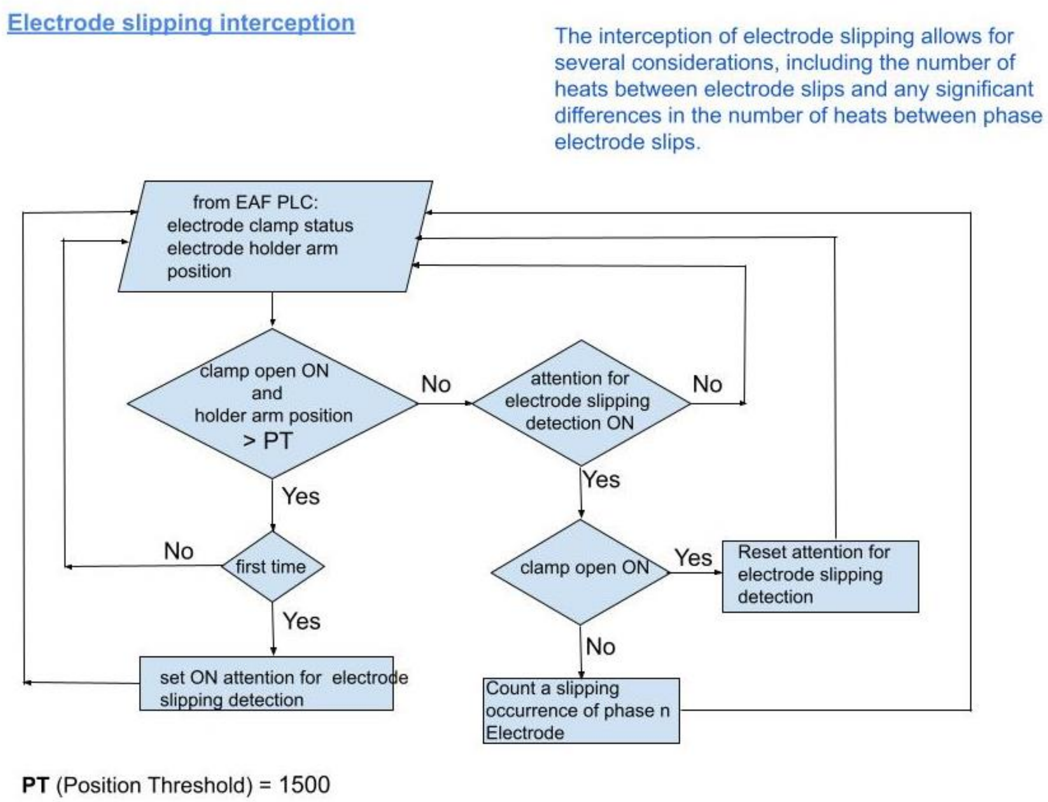
2.2 Electrode replace detection and tip shape classification

The level of side oxidation, indicated by the shape of the electrode tip and assessed through image analysis when the electrode is lifted for replacement, allows for the detection of water cooling and/or air suction issues: manual adjustment of cooling water rate and/or air suction are the corrective actions which could be suggested.



2.3 Electrode slipping interception

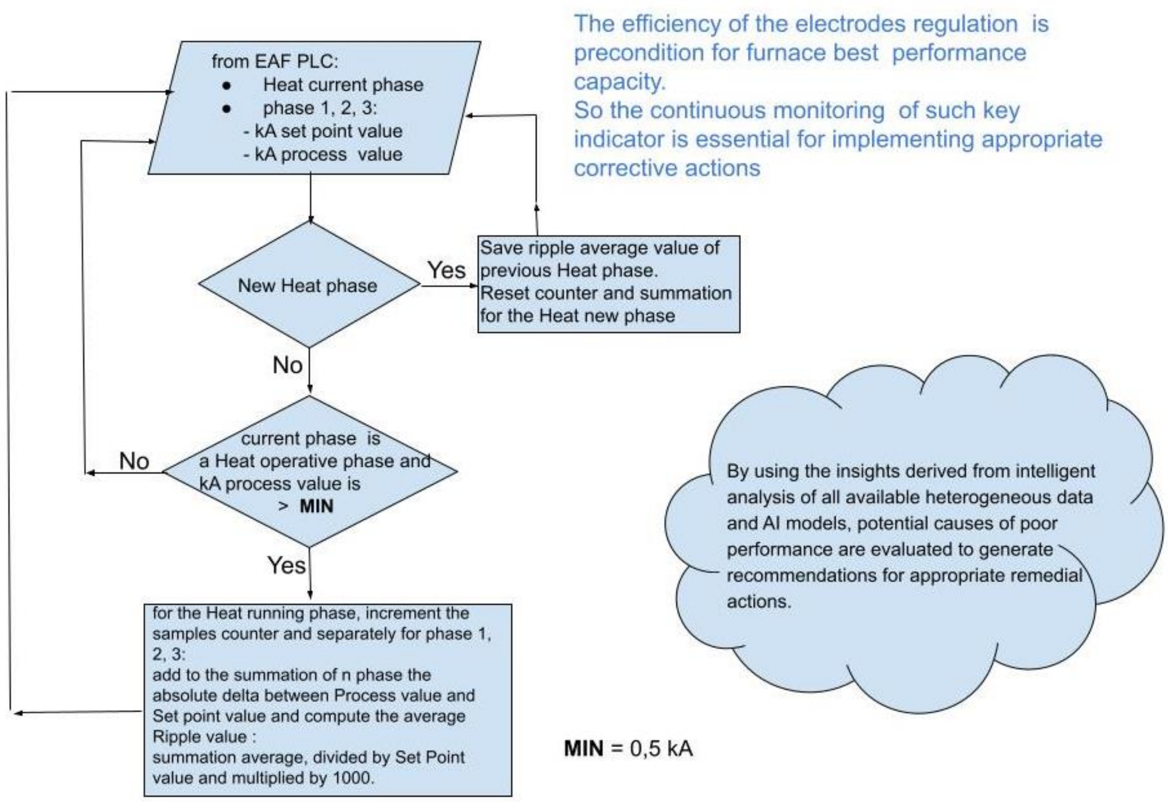
The interception of electrode slipping allows for several considerations, including the number of heats between electrode slips and any significant differences in the number of heats between phase electrode slips: check for frequent slipped electrode water cooling issue and/or electrical run set points are the investigation and corrective actions to suggest.



2.4 Electrodes regulation efficiency- Set Points versus Process Value

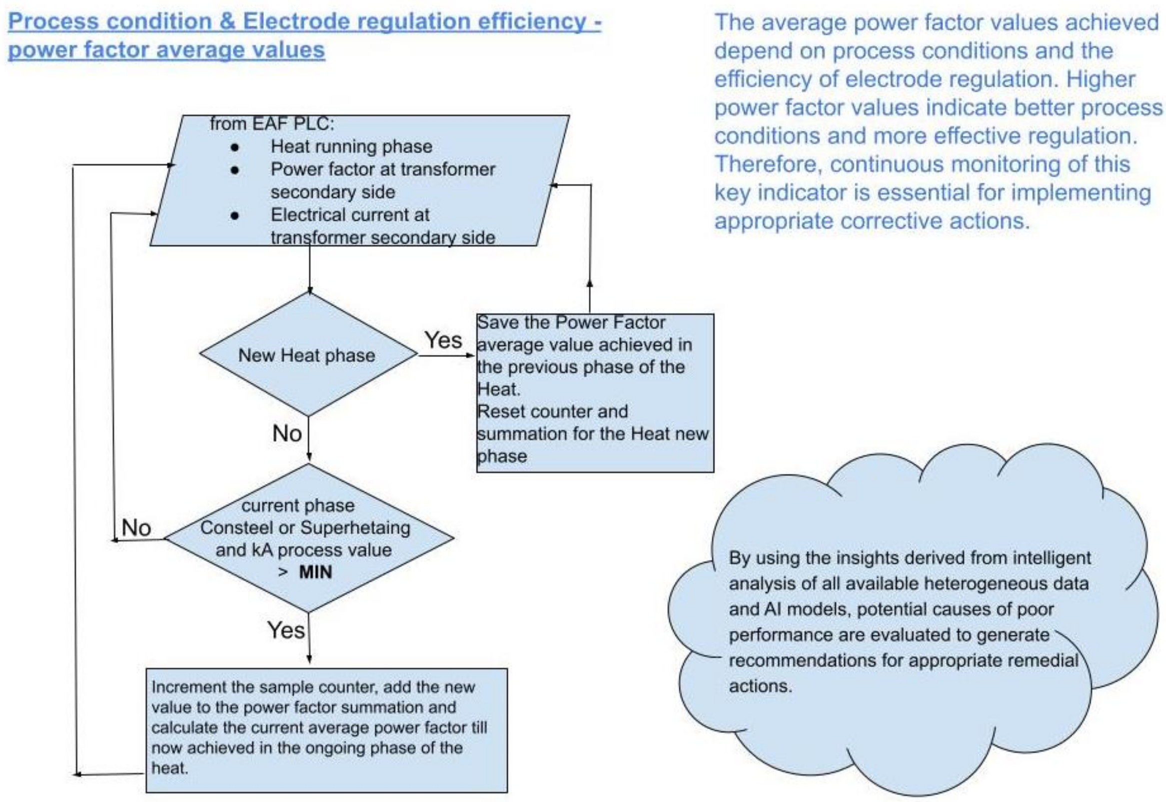
The efficiency of the electrodes regulation is precondition for furnace best performance capacity. So the continuous monitoring of such key indicator is essential for implementing appropriate corrective actions. To check for malfunction of the electrode regulation system is the investigation action which could be suggested.

Electrodes regulation efficiency - Set Points versus Process Values



2.5 Process condition & Electrode regulation efficiency - power factor average values

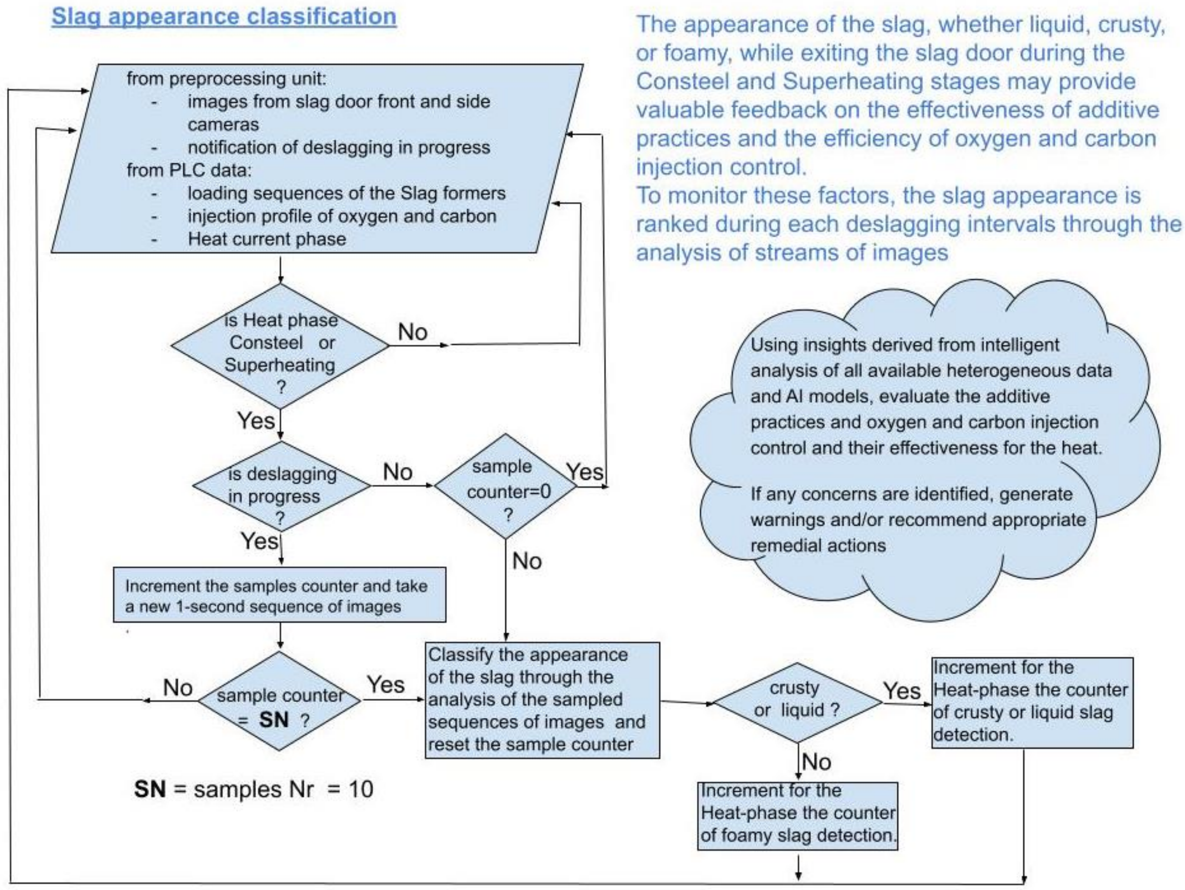
The average power factor values achieved in the different phases of the heat depend on the process conditions and the efficiency of electrode regulation. Higher power factor values indicate better process conditions and more effective regulation. Therefore, continuous monitoring of this key indicator is essential for implementing appropriate corrective actions: In case of low average values, the investigation action and/or the correction action which could be suggested are to check for malfunction of the electrode regulation system and/or to improve the slag management practice to grant foaming slag condition.



MIN = 0,5 kA

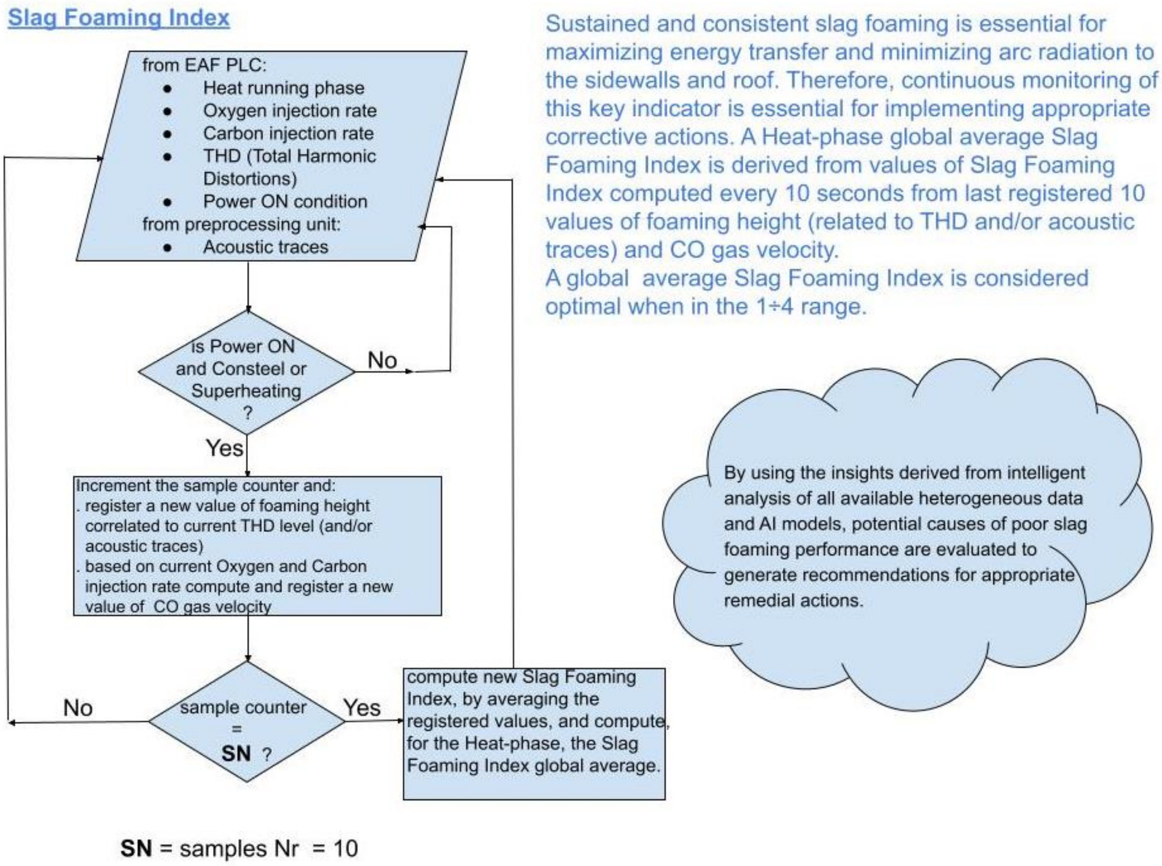
2.6 Slag appearance classification

The appearance of the slag, whether liquid, crusty, or foamy, while exiting the slag door during the Consteel and Superheating stages may provide valuable feedback on the effectiveness of additive practices and the efficiency of oxygen and carbon injection control. To monitor these factors, the slag appearance is ranked during each deslagging intervals through the analysis of streams of images: adjustment of the additive practice and manual adjustment of oxygen and carbon injection that could be suggested.



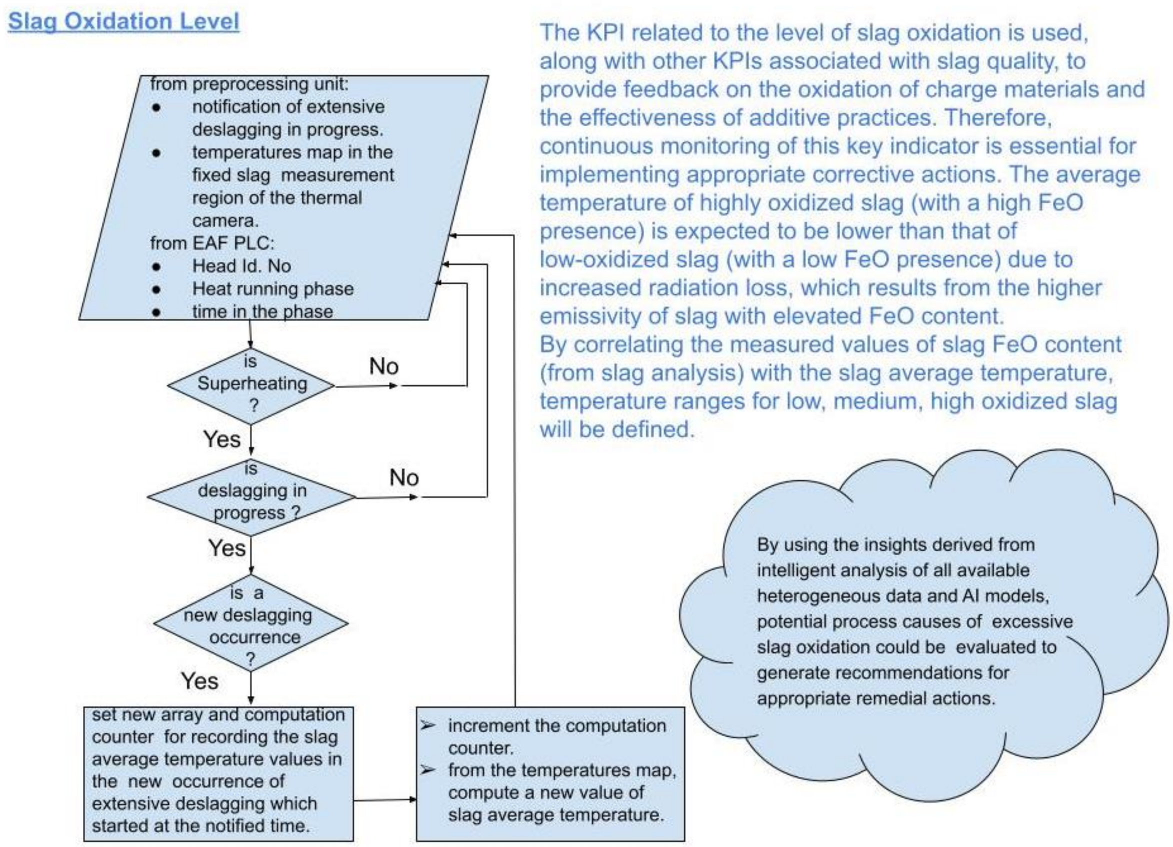
2.7 Slag Foaming Index

Sustained and consistent slag foaming is essential for maximizing energy transfer and minimizing arc radiation to the sidewalls and roof. Therefore, continuous monitoring of this key indicator is essential for implementing appropriate corrective actions with suggestion for adjustment of the additive practice and manual adjustment of oxygen and carbon injection.



2.8 Slag Oxidation level

The KPI related to the level of slag oxidation is used, along with other KPIs associated with slag quality, to provide feedback on the oxidation of charge materials and the effectiveness of additive practices. Therefore, continuous monitoring of this key indicator is essential for implementing appropriate corrective actions which could be adjustment of the carbon injection.



2.9 Slag reactions sensing and ranking

In the Consteel phase, while the furnace is being fed with scrap from Consteel, a dangerous slag reaction may occur. This can be detected by monitoring the development of significant natural deslagging, with the furnace not tilted towards the deslagging side and increase in CO content in the fumes. By monitoring these conditions, the full development of a dangerous slag reaction can be prevented through appropriate countermeasures (interruption of Consteel charge and oxygen/carbon injection), offering significant advantages in terms of safety and production continuity.