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Building Occupational Health and Safety Culture for the RSG-GAS Nuclear Facility at BRIN Serpong

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Abstract

The 30 MW G.A. Siwabessy Multipurpose Reactor Facility (RSG-GAS) at BRIN Serpong is used for research, isotope production, and nuclear technology development and occupational health and safety (OHS) is a very important aspect of the facility. Although there has never been a nuclear accident at the RSG-GAS nuclear facility, to anticipate this, the first study on the possibility of employees making errors at the RSG-GAS facility has been conducted. The aim of this research is to analyze the effectiveness of health, safety and culture of employees working at the Safety division of the reactor RSG-GAS. A mixed method approach with two main perspectives of the workforce and the Institution has been carried out. Data collection and empirical facts that demonstrate the urgency of implementing an OHS/K3 system have been implemented using mix-method. A study of workers' awareness, compliance, and perceptions of OHS implementation, including the application of SOPs in daily operations, was conducted. The results indicate that the effectiveness of OHS implementation at the RSG-GAS BRIN Serpong facility is currently mostly supported by the strength of the regulatory system. The OHS implementation going forward depends not only on adding regulations or improving safety technology, but also on strengthening safety culture consistent training, and a focused, sustainable management commitment. The good implementation of OHS at RGS-GAS BRIN Serpong then makes Indonesia a pioneer in implementing OHS, especially in ASEAN, because the RSG-GAS Reactor is currently the largest nuclear reactor in the Region.

Keywords: Culture, Optimal Safety, Nuclear Facility, RSG-GAS, BRIN

INTRODUCTION

Occupational health and safety (OHS) is a crucial aspect of high-risk industries, including nuclear facilities. Data from the International Labour Organization (ILO) in 2022 noted that each year more than 2.3 million workers worldwide die from work-related accidents and diseases, and there are approximately 340 million cases of non-fatal accidents (Citaristi, 2022). This figure demonstrates the urgency of implementing OHS as a comprehensive protection system.

In general, in the nuclear industry, workplace accidents fall into two categories: nuclear accidents, meaning a person exposed to nuclear radiation (alpha, beta, and gamma). Second, non-nuclear accidents, for example, accidents involving equipment in nuclear power plants (PLTN), where the person involved is not exposed to any radiation at all. In the context of nuclear power, according to a report by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), from 1945 to 2007, at least 35 serious radiation accidents occurred at various facilities, resulting in 32 worker deaths and dozens more suffering from acute radiation syndrome. The 1986 Chernobyl accident killed dozens of workers and emergency personnel within months of the explosion, while the 2011 Fukushima Daiichi disaster demonstrated that natural disasters can trigger a nuclear crisis and increase long-term radiation exposure for workers and the public.

Although nuclear technology offers numerous benefits in the energy and research sectors, the risk of workplace accidents and long-term health impacts remains a significant concern. Recent research from the International Nuclear Workers Study (INWORKS), involving more than 300,000 workers at nuclear facilities in France, the United Kingdom, and the United States, showed a significantly increased risk of death from solid and blood cancers in workers exposed to cumulative low doses of radiation. In addition to radiation risks, physical workplace accidents at nuclear facilities also occur. For example, in March 2025, a worker at the Shimane Nuclear Power Plant in Japan suffered a serious injury after being trapped by a cooling fan, while at the Dounreay facility in Scotland, a falling piece of equipment injured a worker.

A recent report from the French Nuclear Safety Authority (ASN) even recorded a 12.7% increase in workplace accidents at nuclear power plants through 2024. The data shows that occupational safety and health issues in the nuclear industry are not only related to radiation hazards, but also aspects of a comprehensive occupational safety culture, so that the implementation of an effective K3 management system is an urgent need to protect workers and the sustainability of industrial operations (Widjaja et al., 2025). Indonesia is not immune to similar potential risks and in 2025, a case of Cesium-137 (Cs-137) contamination was discovered in the Cikande Industrial Area, Banten, where 9 workers and local residents were declared exposed even though they did not show clinical symptoms (KLHK, 2025).

The 30 MW thermal RSG-GAS facility of the National Research and Innovation Agency (BRIN) Serpong has been operating since 1987 and is a national strategic asset used for research, isotope production, and nuclear technology development. Currently, the BRIN Serpong RSG-GAS nuclear facility is operated by approximately 100 people consisting of operators, OHS staff, and technicians for mechanical, electronic, and safety maintenance. National BAPETEN and International IAEA (International Atomic Energy Agency) safety standards are absolutely necessary considering the operational complexity and potential exposure to radiation and chemicals, especially from the cooling system (Alamsyah & Septilarso, 2023; Atikasari et al., 2022; Bapeten, 2022; Igoniye & Briggs-Kamara, n.d.).

However, the BRIN internal audit report (2022) still shows obstacles, such as non-compliance with the use of personal protective equipment (PPE) and variations in the implementation of SOPs between units. This study is expected to provide an overview of the effectiveness of implementing formal regulations combined with OHS culture in the field, while also generating strategic recommendations to strengthen long-term protection for workers and the sustainability

of nuclear facility operations in Indonesia.

Based on the previous description, the problems to be addressed are a) analyzing the implementation of occupational safety standards set by BAPETEN at the RSG-GAS BRIN Serpong Facility; b) measuring the level of implementation of the OHS culture SOP in employee work activities; c) analyzing the relationship between the implementation of BAPETEN standards and OHS culture towards improving employee occupational safety; d) identifying supporting and inhibiting factors for the implementation of OHS culture in the reactor work environment; and e) evaluating the impact of the implementation of BAPETEN standards and OHS culture SOP on employee occupational safety conditions at the RSG-GAS nuclear reactor facility. Therefore, the objectives of this study are a) analyzing the implementation of OHS at the RSG-GAS BRIN Serpong Multipurpose Reactor Facility; b) identifying factors that support and inhibit the implementation of OHS culture at the RSG-GAS BRIN Serpong Multipurpose Reactor Facility.

The research that has been conducted is very interesting and unique, considering that the RSG-GAS BRIN Serpong nuclear facility is the largest nuclear facility in Indonesia and even in Southeast Asia today, and was even the largest nuclear facility in the world in the 1980s. This research was conducted for the first time in relation to the development of K3 SOPs linked to HR management and development, because it is absolutely necessary to guarantee the implementation of K3 at the current and future RSG-GAS BRIN Serpong facility. All previous research state that risk management and organization in the nuclear industry, along with the regulatory context and trust, are crucial for safety.

The research focuses on nuclear waste management and stakeholder trust, although not directly on the implementation of OSH SOPs at reactor facilities. All research (Bjelland & Njå, 2022; Fang et al., 2023; Kim, 2022; Nunen et al., 2022) discuss extensively the integration of safety and security management in the nuclear industry, as well as safety (OSH SOPs) at nuclear facilities. This research is also supported by researches on comprehensive safety and security aspects across countries focusing on the OSH aspects of workers within a single facility. Finally, the role of norms, management, and technological innovation are crucial for proper and proper implementation of OHS, especially for high-risk facilities, including nuclear facilities (Arfah et al., 2024; Canet et al., 2024; Manurung & Hendayana, 2025; Putri et al., 2024).

METHODS

To begin this research, a presentation of empirical data and facts demonstrate the urgency of implementing an OHS system in high-risk industries, such as, the nuclear sector. Data from UNSCEAR and INWORKS (International Nuclear Workers Study) are also included due to the numerous radiation incidents at nuclear facilities worldwide that have caused long-term health impacts. These facts reinforce the urgency of examining how safety culture and compliance with OHS standards are implemented in Indonesian nuclear facilities which meet with Standards and SOPs of BAPETEN.

The SOPs for nuclear facilities serve as operational technical guidelines that ensure all work activities are conducted in accordance with safety principles and accident risk prevention. The previous two foundations serve as a reference for assessing the extent to which the implementation of the OHS system in the field aligns with applicable regulations. A mixed method which has been utilized allows researchers to deeply explore into the actual conditions in the field and the analysis was conducted from both the workforce, company perspectives.

RESULTS

Implementation of general research results

Research was conducted at the RSG-GAS BRIN Serpong facility and within BRIN's organizational structure, nuclear facility safety management falls under the Directorate of Nuclear Facility Management (DPFK). This directorate plays a primary role in ensuring that all nuclear facility operations, including RSG-

GAS facility, comply with applicable safety requirements, both from national regulations and internal organizational standards. The DPFK is responsible for risk control, overseeing the implementation of OSH Standard Operating Procedures (SOPs), and coordinating between work units directly involved in reactor operations.

The RSG-GAS facility is under the regulatory oversight of BAPETEN, and the standards and regulations issued by BAPETEN serve as the primary reference for OSH implementation, particularly regarding radiation protection. These regulations cover radiation dose control, work permit requirements for personnel, the use of radiation monitoring equipment, and the application of radiation protection principles, such as, justification, dose limitation, and optimization. In practice, these standards are not merely understood as formal obligations, but serve as the basis for operational decision-making in the field.

The implementation of OHS at RSG-GAS involves various roles and functions, from operational management, OHS and radiation protection officers, to workers and third parties entering the facility area. Safety managers and operations and maintenance managers are responsible for ensuring that all work activities are carried out safely and securely according to procedures, while OHS and radiation protection officers play a role in providing assistance, supervision, and direct risk control. Workers are expected not only to comply with regulations, but also to be aware of the potential hazards inherent in the nuclear work environment.

The work context at RSG-GAS shows that OHS implementation is inseparable from technical control systems and mechanisms. The use of personal protective equipment, radiation dosimeters, limited access systems, and other monitoring devices are part of routine activities. These systems are designed to minimize the possibility of human error and ensure that all personnel entering the work area have met the established safety requirements.

Research data and information were achieved from key informants through in-depth interviews and they have strategic roles in the management and implementation of OHS, namely, operations and maintenance managers, safety managers, OHS/PPR officers, reactor supervisors/operators, and sources who act as expert judges. Through this approach, the research not only looks at compliance with BAPETEN SOPs and standards, but also examines how safety values, habits, and behavior patterns are practiced and interpreted by actors within the organization. Furthermore, it will see how the implementation of BAPETEN standards and OHS SOPs is carried out in practice, as well as the factors that support or hinder the formation of an occupational safety culture at the RSG-GAS facility.

Implementation of BAPETEN standards for OHS SOPs in daily work practices

The implementation of OHS at the RSG-GAS facility daily work practices is carried out by all personnels. Based on in-depth with all responsible people previously mentioned, the implementation of BAPETEN standards has been internalized in work routines, particularly in activities involving radiation areas and high-risk facilities. These safety practices are implemented in a layered manner through the use of personal protective equipment, personnel control systems, and assistance from radiation protection officers. In practice, all OHS implementation at the RSG-GAS facility is categorized into the following activities:

- Occupational safety routines in the RSG-GAS

Environment OHS implementation at the RSG-GAS environment appears to be integrated into the workers' daily work routines. Every personnel entering the work area automatically equips themselves with basic personal protective equipment (PPE), such as, a work-pack, safety shoes, and a radiation dose measuring device. This practice has become a habit, carried out without the need for repeated instructions. The use of personal dosimeters is a crucial element of safety routines, particularly for radiation workers. In addition, personnel are provided with dosimeters and dose measurements are taken before and after work to ensure workers' radiation doses are kept as low as possible, below established dose limits.

This demonstrates that safety standards are not merely understood as written rules but have been internalized as work norms agreed upon by all personnel.

- Personnel control and work mechanisms

Personnel control at RSG-GAS is carried out through a strict work permit mechanism, especially in areas with the potential for high radiation exposure. Every work activity must be coordinated with the Radiation Protection Officer (PPR) prior to implementation. The work duration, number of personnel, and implementation methods are determined based on the measured radiation risk level. Furthermore, workers are not permitted to enter certain areas without the assistance or approval of authorized personnel. This serves as a safety measure to minimize human error and ensure that all work is carried out in accordance with safety principles. Risk awareness is fostered through binding procedures that are mutually enforced.

- Implementation of BAPETEN standards for OHS SOPs

The implementation of OHS SOPs at nuclear research facilities is developed and implemented in accordance with the radiation safety regulatory framework established by BAPETEN, the regulatory authority for nuclear energy in Indonesia. These regulations emphasize that every nuclear energy utilization activity must ensure the safety of workers, the public, and the environment through a radiation protection system that is planned, documented, and continuously evaluated.

The optimization principle is realized through the application of the ALARA principle, where radiation exposure is attempted to be as low as reasonably possible by considering technical and operational aspects. The dose limitation principle is implemented by controlling individual radiation exposure to keep it below the Dose Limit Values established by BAPETEN. The mandatory use of Personal Protective Equipment (PPE) before entering a radiation area is a direct implementation of BAPETEN's radiation protection standards, which prioritize individual protection as a critical element in risk control.

The implementation of the ALARA principle is also reinforced by procedures to mitigate potential human error, such as the use of work checklists, a work permit system, and multi-layered supervision of activities in radiation areas. This approach reflects the defense-in-depth concept in nuclear safety, where risk is controlled through a combination of technical, administrative, and behavioral controls, as recommended in BAPETEN's safety standards. Evaluation and audits of OHS SOPs are conducted periodically through internal and external audits, including audits by BAPETEN at least once a year.

This audit process serves as a tool for monitoring regulatory compliance and as a means for continuous improvement of OHS and radiation safety systems. Audit findings serve as the basis for refining SOPs, enhancing protective equipment, and strengthening the safety management system at research facilities.

Overall, the analysis results indicate that the implementation of the K3 SOP is aligned with radiation protection theory and BAPETEN standards, both in terms of planning, implementation, and evaluation. This indicates that the K3 SOP functions not only as an administrative document, but has been effectively implemented as a system for controlling occupational safety risks and radiation protection in the research facility environment.

- Technical systems and safety oversight

This is key to enforcing SOPs and a safety culture in the field, and the implementation of technology and oversight procedures including interlock systems and access controls to laboratories and radiation areas which are authorized by supervisors. Worker radiation doses are then periodically monitored, and the results recorded to ensure and evaluate optimization principles. Safety patrols and documentation are conducted routinely by OHS officers and document SOP violations.

Internal inspections and audits by BAPETEN ensure SOPs are implemented according to standards and provide recommendations for improvements if deficiencies are found. All of these approaches integrate technology, human

oversight, and a safety culture, making OHS implementation more effective and sustainable.

• Dynamics of OHS implementation in organizational change

The organizational change from BATAN to BRIN affected the consistency of OHS implementation. Several factors were identified: a) The new management structure and human resource transfers affected the continuity of SOP implementation; b) The focus on safety declined at the beginning of the transition, but has since been improved through the procurement of PPE and regular outreach; c) Safety culture drivers ensure that OHS practices are maintained despite the management change; and d) Leadership commitment and individual consistency are key to maintaining a strong OHS culture amidst organizational dynamics.

Table 1 further shows that OHS implementation at the BRIN Serpong RSG-GAS facility has been carried out in accordance with all BAPETEN regulations, from planning and organizing relevant human resources, to implementation, supervision, and evaluation of all operational aspects of the BRIN Serpong RSG-GAS facility. Table 2 further identifies the OHS implementation domains from a workforce perspective.

Table 1. Identification of OHS implementation domains from a company perspective

No.	Sub-Domain of OHS Implementation	Mean of Domain from a Company	Sign from Interview
1.	Standard of BAPETEN for OHS-SOP	SOPs are positioned as formal organizational instruments to control occupational safety and regulatory compliance.	SOPs are developed from BAPETEN's Regulations, routinely audited, and are a requirement for work permits.
2.	Radiation Protection and ALARA	Principle of Radiation protection includes in working system and organization policy	PPR assistance, work arrangements, internal dose limits.
3.	Safety Technical System	Safety is designed through technical systems to reduce reliance on individual behavior.	Interlock, dosimeter, hand foot monitor and monitoring doses
4.	OHS Monitoring Structure	The company provides a formal safety oversight structure.	K3 officers, PPR, RPK, vendor assistance.
5.	Policy and Management Support	Management is responsible for providing safety resources.	PPE procurement, audits, work termination if SOPs are violated.
6.	Training System and Licensing	The company monitors workers' competency before they start work.	Initial training, certification, operating license
7.	Evaluation & Sustainable Repair	Safety is monitored and improved through formal mechanisms.	BAPETEN audits, internal evaluations, and follow-up on findings.

Source: Analysis in 2026.

Table 1 shows that workers have understood that all OHS implementation at the RSG-GAS BRIN Serpong facility must comply with all BAPETEN and international regulations. Therefore, the operation of the RSG-GAS BRIN Serpong facility by healthy workers can be guaranteed safe. Furthermore, Table 2 shows the Identification of OHS Implementation Domains from the BAPETEN standard perspective for OHS SOPs.

Regarding the implementation of OHS at the RSG-GAS BRIN Serpong facility, interviews were conducted with the Operations and Maintenance Manager, Reactor Supervisor, Reactor Operator, Radiation Protection Technician (PPR), and Safety Manager. The interviews focused on the implementation of a) BAPETEN standards for OHS SOPs; b) Radiation protection & ALARA; c) Safety technical systems; d) Occupational safety culture; and e) OHS training and socialization. In summary, it can be concluded that points a, b, and c are strong, while points d and e are still weak and require future improvement.

Finally, all interviewed workers, whose duties and authorities are stated that: a) OHS SOPs are always implemented in daily activities; workers are required to wear PPE and dosimeters before entering the work area; work access is denied if the SOPs are not met; b) All work complies with BAPETEN regulations; regulatory changes (e.g., dose limits) are always socialized and understood by workers; c) SOPs are derived from BAPETEN standards and are audited periodically; audit results generate recommendations for improvement within specific deadlines; d) Radiation protection SOPs are implemented consistently; radiation

Table 2. Identification of OHS implementation domains from the workforce side

No.	Sub-Domain of OHS Implementation	Mean of Domain from Employee	Sign from Interview
1.	BAPETEN Standard dor OHS-SOP	Radiation protection is perceived as direct personal protection.	Dosimeter use, PPR assistance, and work precautions.
2.	Radiation Protektion and ALARA	Technical systems are considered everyday safety tools.	Use of dosimeters, PPR assistance, work precautions
3.	Technical Safety System	Technical systems are considered everyday safety tools.	Loan dosimeters, radiation monitoring, pre-work measurements
4.	Operational Health Safety	Safety becomes a collective habit and a mutual reminder.	Remind each other, do not work without protection.
5.	Training and Socialization of OHS	Training builds initial understanding, socialization reinforces habits	Initial training for radiation workers, regular socialization
6.	Risk Perception & Job Comfort	K3 affects feelings of safety and comfort at work.	Feeling protected and safe, even when there are PPE complaints.
7.	Individual Compliance & Behavior	Compliance arises from habit, not from sanctions.	There are no formal sanctions, but social pressure is quite strong.

Source: Analysis in 2026.

safety is stricter than general non-radiation safety and e) SOP implementation complies with BAPETEN Regulations and aligns with IAEA standards; compliance is ensured through technical systems and safety interlocks.

International nuclear and radiological event scale of the International Atomic Energy Agency (IAEA)

The International Nuclear and Radiological Event Scale (INES) is a tool for cooperating the safety significance of nuclear and radiological events to the public (IAEA, 2026) and IAEA Member States utilize INES on a voluntary basis to rate and connect events that occur within their territory. It is not a proclamation or reporting system to be used in emergency response. INES deals with events at facilities and activities involving radiation sources. It is used for the rating of events that result in a reprieve of radioactive material into the environment and in the radiation exposure of workers and the public. The scale is affected to events involving the loss or theft of radioactive sources and the discovery of frenzied radioactive sources in scrap metal. INES is projected for practise in non-military utilization and only relates to the safety aspects of an event. It also should not be applied to activate emergency response actions and INES rating descriptions are seen in Figure 1.

As seen in Figure 1, events are rated at seven levels and the scale is logarithmic, namely, the severity of an event is about ten times greater for each increase in level of the scale. Events are considered in terms of impact on people and the environment, impact on radiological barriers and control and impact on defence in depth. Events without safety significance are rated as Level 0 and those, that have no safety relevance with respect to radiation or nuclear safety are not rated on the scale. More than 80 IAEA Member States have designated INES National Officers and Member States are encouraged to share information on events rated at Level 2 and above and events attracting international public interest through NEWS (IAEA, 2026) which lists publicly events that were reported in the past 12 months.

INES has developed since 1990 by the IAEA and the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD). The scale was initially applied to classify events at nuclear power plants, then extended and adapted to enable it to be applied to all installations associated with the civil nuclear industry. It has subsequently been extended and adapted further to meet the growing need for communication of the significance of all events associated with the use, storage and transport of radioactive material and radiation sources. The RSG-GAS has been

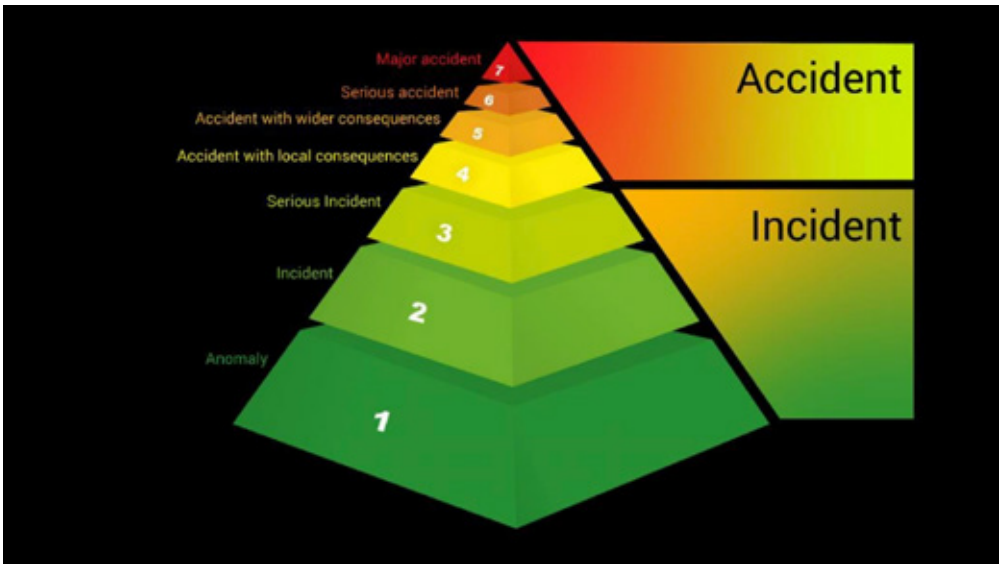

Figure 1. A numerical rating indicator of the significance of nuclear or radiological events (IAEA, 2026).

operation since 1987 and there has never been accident categorized by INES.

In RSG-GAS BRIN Serpong, every employee carries out OHS duties at RSG-GAS by conducting a) daily radiation surveillance monitoring; b) radiation work permit and every work in the radiation area must go through a risk analysis permit system before work begins as well as maximum work duration; c) radioactive contamination control that focuses on monitoring contamination of hands, clothing and equipment used; d) industrial safety (non-radiological hazards) and all workers must follow general industrial K3 standards for nuclear standards; e) operational emergency preparedness for all incidents including coordination with BAPETEN as nuclear regulator; f) reactor area access control and reactor area access control; g) occupational health monitoring safety training & certification and h) implementation of the principle of alarm in operations. Briefly, OHS in the nuclear industry is summarized as carrying out direct radiation protection in the field, technical work safety (mechanical, electrical, etc.), rapid response to abnormal conditions and comprehensive worker protection.

Table 3 below shows the results of the 2021-2025 assessment of the GAS RSG-GAS BRIN Serpong conducted by BAPETEN as the National Nuclear Regulatory Body

As previously mentioned, BAPETEN conducts audits at least once a year unless there is an unspecified event outside the predetermined plan. The assessment prioritizes four aspects, such as, field radiation protection, technical work safety (mechanical, electrical, etc.), prompt response to abnormal conditions, and overall worker protection. Generally, the values listed in Table 3 are summarized from the values for each subsection mentioned previously. Furthermore, for this year, BAPETEN will conduct the OHS implementation assessment at RSG-GAS BRIN Serpong at the end of 2026.

Table 4 shows BAPETEN's predicted assessment based on rational assumptions from the previous results since 2021. Indeed, a rational comparative assessment was taken from year to year, the final assessment prediction for 2025/2026 from the BAPETEN assessment will then end at a minimum value of 8.26 or good.

Table 3. Implementation grade of OHS at RSG-GAS BRIN by BAPETEN in 2021-2025

	Grade (6-10) (Not Satisfied – Perfect)					
Items of OHS	**2021**	**2022**	**2023**	**2024**	**2025**	**Average**
Radiation protection at the field (1)	7,1	7,2	7,8	8,1	8,2	7,68
Technical work safety (mechanic, electric etc.) (2)	7,5	7,4	8,0	8,3	8,3	7,90
Prompt response to abnormal condition (3)	7,4	7,5	7,6	8,2	8,1	7,76
A whole worker protection (4)	7,7	7,8	8,1	8,4	8,4	8,08

Grade: 6-Not satisfied; 7-Good enough; 8-Good; 9-Very good; 10-Perfect.
Source: Analysis in 2026.

Table 3. Grade prediction of OHS at RSG-GAS BRIN by BAPETEN in 2026

Items of OHS	Grade (6-10) (Not Satisfied – Perfect)					
	2022/2021	2023/2022	2024/2023	2025/2024	2026/2025 Predictive grade	2026 Predictive grade
Radiation protection at the field (1)	1,01	1,08	1,03	1,03	1,03	8,53
Technical work safety (mechanic, electric etc.) (2)	0,99	1,08	1,04	1,00	1,03	8,59
Prompt response to abnormal condition (3)	1,01	1,01	1,08	0,99	1.02	8,26
A whole worker protection (4)	1,01	1,03	1,03	1.00	1,01	8,48

Grade: 6-Not satisfied; 7-Good enough; 8-Good; 9-Very good; 10-Perfect.
Source: Analysis in 2026.

DISCUSSION

From all explanation previously mentioned that the application of OHS at the RSG-GAS BRIN Serpong facility has been running well and shows a high level of obedience with the OHS SOP and BAPETEN standards. The implementation of OHS from all facets can be branded as a strong and relatively stable domain. The effectiveness of the OHS culture is, however, not yet fully evenly dispersed and sustainable and in non-radiation safety aspects, behavioral discrepancies are still found, even though SOPs and facilities are accessible. Partial OHS exercise and socialization are one of the hindering factors in the efficacy of the safety culture.

As seen in Figure 1, the International Nuclear and Radiological Event Scale (INES) has been developed since 1990 by the IAEA (International Atomic Energy Agency) and the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD). The scale was originally utilized to categorize events at nuclear power plants, then prolonged and improved to allow it to be practical to all installations realted to the public nuclear industry.

It has been afterwards extended and adapted further to meet the growing need for communication of the implication of all events allied with the use, storage and conveyance of radioactive material and radiation sources. Indeed, the RSG-GAS has been activated since 1987 and there has never been at all accident categorized by INES.

Regarding the assessment results in Table 3, it indicate that the overall assessment of technical occupational safety and point 1 worker protection in the field is relatively simpler compared to the other two main tasks. It should be noted that in 2020, when Covid-19 hit the world, the scores were still quite good, as work procedures differed from those under normal conditions.

When conditions return to normal in 2022, the work procedures at RSG-GAS BRIN Serpong were different from those in 2020 and 2021. Considering the assessment results from previous years and specifically in 2026, BAPETEN is very optimistic that the OHS assessment by the nuclear regulator BAPETEN will improve. Based on the assessment predictions from previous years, BAPETEN's predicted OHS assessment of RSG-GAS in 2026 will range from an average of 8.26 or good.

In 1980s, the RSG-GAS facility Serpong was the largest nuclear reactor in the world, but as time went by, especially in East Asia, Japan, Korea and China then built research reactors with a power of more than 50 MW, however, currently, RSG-GAS BRIN Serpong remains the largest research nuclear reactor in ASEAN. As previously mentioned, OHS has been implemented well at

the RSG-GAS BRIN Serpong facility.

All agree that the implementation of OHS reflects the implementation of nuclear safety culture in Indonesia has been running well and in accordance with BAPETEN and International regulations. This makes Indonesia a pioneer in the implementation of OHS and nuclear safety culture especially in ASEAN. It is, therefore, very possible that the construction of nuclear power plants (PLTN) in Indonesia can be fully supported by neighboring countries, such as Singapore, Malaysia, the Philippines and others.

CONCLUSION

From the previous description, it can be concluded that the implementation of OHS at the RSG-GAS BRIN Serpong facility has been running well and shows a high level of compliance with the OHS SOP and BAPETEN standards. The application of radiation protection and the ALARA principle is an integral part of the work safety system, and hence not only meeting BAPETEN national standards, but also IAEA safety standards.

The implementation of OHS from all aspects can be categorized as a strong and relatively stable domain. The combination of OHS SOPs, BAPETEN standards, safety audits, and safety technical systems forms a solid foundation in preventing work accidents and radiation exposure. The effectiveness of the OHS culture is, however, not yet fully evenly distributed and sustainable and in non-radiation safety aspects, behavioral inconsistencies are still found, even though SOPs and facilities are available. Limited OHS training and socialization are one of the inhibiting factors in the effectiveness of the safety culture.

Although basic training and mandatory certification have been implemented, advanced training and routine outreach activities still need to be improved. The OHS implementation is largely supported by the regulatory system, so the situation emphasizes that the forward challenge of OHS implementation lies not only in adding improving safety technology, but also in strategies to strengthen safety culture, consistent training, and sustained managerial commitment. The good implementation of OHS at RGS-GAS BRIN Serpong then makes Indonesia a pioneer in implementing OHS, especially in ASEAN, because the RSG-GAS Reactor is currently the largest nuclear reactor in the Region.

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