

Revision of IAEA Site Evaluation Standards: Key Changes in SSR-1 and SSG-18

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1. Introduction

IAEA Safety Standards Series No. SSR-1, Site Evaluation for Nuclear Installations, establishes requirements for identifying and evaluating natural and human induced external hazards, deriving site specific design parameters, assessing interactions between the site and the installation, and supporting the assessment of radiological impacts and emergency response feasibility. Since its 2019 publication, the scope and technical context of site evaluation have continued to evolve. New reactor concepts, transportable and floating installations, climate change, combined external events, and the need for more explicit reassessment of external hazards have created a demand for a more integrated framework. DS557, the draft revision of SSR-1, and DS541, the draft revision of SSG-18, respond to this need by strengthening the safety requirements and supporting guidance for site evaluation.

2. Main Changes in the revision of SSR-1

The revision of SSR-1 can be understood as a restructuring of the existing framework rather than a complete replacement. Several concepts already present in SSR-1, such as the graded approach, lifetime evaluation, hazard combinations, uncertainty treatment and periodic review, are strengthened and made more systematic. At the same time, DS557 introduces important new elements, especially the explicit treatment of mobile installations and the formalization of site suitability criteria. The major revision criteria summarized in Table 1.

2.1 Graded approach as a cross-cutting principle

SSR-1 already requires the application of a graded approach commensurate with the radiation risk posed to people and the environment. However, DS557 moves the graded approach from a scope-setting principle to a cross-cutting principle linked to optimization of protection. It emphasizes that the application of the graded approach should be transparent, justified in documentation, and consistently applied across all requirements addressing site evaluation. This is a major strengthening because grading is no longer limited to determining the level of detail; it becomes a governing principle for investigations, analyses, assessments, monitoring, reassessment and documentation.

2.2 Formalization of site suitability criteria

SSR-1 includes a requirement on site suitability and states that the suitability of the site should be assessed at an early stage and confirmed for the lifetime of the installation. DS557 retains this concept but formalizes the judgement by introducing site suitability criteria based on selected safety-related site characteristics, or attributes, and specific quantitative performance limits. This change clarifies that site suitability is not only a qualitative judgement. It is to be evaluated through the relationship between relevant site attributes, such as external hazards, dispersion characteristics, emergency response feasibility, ultimate heat sink considerations and time-dependent changes, and defined performance limits. This approach is more compatible with a performance-oriented framework, while still recognizing that engineering solutions and protective measures may compensate for certain site deficiencies.

2.3 Expansion to mobile installations

One of the most explicit changes in DS557 is the expansion of scope from stationary installations to both stationary and mobile installations. SSR-1 applies to all nuclear installations and lists the principal types of facilities, but it does not define a separate site evaluation framework for mobile or transportable installations. DS557 explicitly states that the requirements apply not only to stationary installations but also to mobile installations, including installations that may be relocated and either are shut down prior to transportation or operate during transportation. This broadens the meaning of a site from a fixed geographical area to a dynamic operational and deployment environment.

2.4 Independent participatory review

SSR-1 requires an independent review of the evaluation of external hazards, site-specific design parameters and potential radiological impact. DS557 strengthens this requirement by introducing an independent participatory review of both the process used and the results obtained. The scope is expanded to include the demonstration of the feasibility of implementing emergency response actions. In addition, the review approach, results, reviewer qualifications and disposition of comments are to be documented. The term participatory should be understood primarily as an

ongoing and interactive peer review process rather than simple public participation. Its purpose is to improve transparency, traceability and defensibility of the assessment process, particularly where expert judgement, model selection and uncertainty treatment are important.

2.5 Reassessment, hazard combinations and key safety functions

DS557 also strengthens several existing concepts. Reassessment is more directly linked to the confirmation of site-related design bases and to upgrading measures where deviations are identified. Hazard combinations are considered not only during hazard evaluation but from the identification and screening stage. Uncertainty treatment is reframed as a process requiring identification, quantification and treatment of uncertainties from the beginning of the site characterization phase and consistent application throughout the assessment process. In addition, DS557 integrates hazards associated with loss of offsite power, station blackout and loss of ultimate heat sink into the credible external hazard identification process. This does not mean that LOOP, SBO and UHS loss are themselves external hazards; rather, it means that external hazards should be screened with explicit attention to their potential to challenge key safety functions and installation vulnerabilities.

Table 1. Revision of SSR-1

Change area	Revision direction in DS557
Graded approach	Elevated from a scope-setting principle to a cross-cutting principle applied consistently across all site evaluation requirements.
Site suitability criteria	Formalized through safety-related site attributes and specific quantitative performance limits; suitability becomes more explicitly performance-oriented.
Stationary and mobile installations	Scope is expanded from fixed sites to stationary and mobile installations, including operational envelopes for installations operating during transportation.
Independent participatory review	Strengthened from independent review of results to review of both the assessment process and results, including reviewer qualifications and disposition of comments.
Climate change	Explicitly incorporated as a factor that can alter hazard frequency, intensity and duration over the lifetime of the installation.
Lifecycle reassessment	Site evaluation is structured as a continuous process from initial planning to decommissioning, with reassessment linked to design basis validation and upgrading if needed.
Key vulnerabilities	Credible external hazards are linked to conditions such as loss of offsite power, station blackout and loss of ultimate heat sink, depending on design vulnerabilities.

3. Main changes in the revision of SSG-18 (DS541)

SSG-18 supplements the requirements for site evaluation by providing guidance on the assessment of hazards associated with meteorological and hydrological phenomena external to nuclear installations over their lifetime. The revision identified as DS541 is titled Meteorological, Hydrological and Other Natural Hazards in Site Evaluation for Nuclear Installations. Publicly available draft information indicates that DS541 is intended to supersede SSG-18 and to update the guidance for compatibility with updated safety requirements and supporting technical documents. The revision also reflects lessons learned after the Fukushima Daiichi accident, recent developments in tsunami hazard estimation, uncertainty in hazard estimation, beyond design basis external events, safety margins and multiple hazard combinations.

Table 2. Revision of SSG-18

Key change	Implication for site evaluation guidance
Climate change	Guidance is expected to place stronger emphasis on long-term changes in extreme precipitation, flooding, sea level, storm surge, waves, drought, temperature and related uncertainties.
Multiple hazard combinations	Evaluation is broadened from individual hazards to simultaneous, sequential and causally related combinations, such as typhoon, storm surge, waves and extreme rainfall at coastal sites.
Beyond design basis hazards	Hazard parameters are used not only for design basis definition but also for margin assessment, cliff-edge evaluation and beyond design basis safety assessment.
Other natural hazards	The scope is broadened to selected hazards such as wildfire, drought, biological phenomena, ice, debris and space weather where relevant to safety functions, site access, cooling and emergency response.
Offshore and mobile concepts	Guidance is expanded to address offshore locations, floating facilities and transportable reactors, including routes, ports, marine conditions and operational envelopes.

4. Integrated implications

The combined revisions of SSR-1 and SSG-18 indicate a shift in site evaluation practice in several directions. First, site evaluation is becoming more explicitly performance-oriented. The introduction of site suitability criteria based on attributes and quantitative performance limits encourages a more traceable relationship between site characteristics, safety objectives and decision criteria. Second, site evaluation is becoming more lifecycle-oriented. It is no longer sufficient to establish design parameters at the site characterization stage; the validity of those parameters must be monitored and reassessed in light of new data, operating experience, changes in hazards, climate change and new methods.

Third, external hazard assessment is becoming more integrated with safety functions and plant vulnerabilities. Hazards should not be screened only on the basis of their physical intensity or historical occurrence. They should also be evaluated in terms of their potential to cause LOOP, SBO, UHS loss, loss of access, degradation of emergency response or cascading effects across multiple installations. Fourth, the framework is expanding beyond conventional fixed land-based facilities. Mobile, transportable, floating or offshore concepts require evaluation of dynamic operational envelopes rather than only static geographical site regions.

Finally, uncertainty management becomes a central regulatory and technical issue. Climate projections, extreme value analyses, compound hazard modelling, tsunami and storm surge simulations, hydrological modelling and biological or debris-related hazards all involve significant uncertainties. The revisions suggest the need for transparent methods to identify, quantify, treat and communicate uncertainties in a way that supports graded decision-making, design basis derivation, beyond design basis evaluation and reassessment.

5. Conclusions

The revision of SSR-1 as DS557 and the revision of SSG-18 as DS541 represent an important evolution in the IAEA framework for site evaluation. DS557 reorganizes existing SSR-1 concepts into a more explicit graded, performance-oriented and lifecycle-based framework. Its most significant changes include the formalization of site suitability criteria, expansion to mobile installations, independent participatory review, explicit consideration of climate change, stronger reassessment linked to design basis validation, and closer attention to key safety function vulnerabilities such as LOOP, SBO and UHS loss.

DS541 complements this evolution by updating the guidance for meteorological, hydrological and selected other natural hazards. Its main directions include stronger treatment of climate change, multiple hazard combinations, beyond design basis hazard parameters, other natural hazards, and offshore or mobile deployment concepts. Together, these revisions suggest that future site evaluation should be more integrated, dynamic and risk-informed, with stronger linkage among hazard characterization, site suitability, design input, safety assessment, reassessment, and emergency response feasibility throughout the lifetime of the installation.

REFERENCES

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