July 22, 2025

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

**Subject: BTI Comments on the ADVANCE Act: Utilizing Offsite Meteorological Data**

Dear U.S. Nuclear Regulatory Commission Staff:

The Breakthrough Institute (BTI) appreciates this opportunity to comment on ongoing NRC activities on off-site meteorological data considerations for new nuclear siting and deployment related to the implementation of the ADVANCE Act. BTI is an independent 501(c)(3) global research center that advocates for appropriate regulation and oversight of nuclear reactors to enable the new and continued use of safe and clean nuclear energy. BTI acts in the public interest and does not receive funding from industry.

The NRC has an opportunity to seize practical efficiencies that reduce regulatory bottlenecks without compromising safety. Among these, recognizing the validity of off-site meteorological data, when scientifically justified, is one of the most straightforward and impactful tools available to support timely, efficient reviews.

It is essential that the NRC maintain strong protections for public health and safety while reducing unnecessarily prescriptive or outdated siting requirements that can slow the deployment of advanced nuclear reactors. Existing guidance requires multiple years of onsite meteorological data collection, which also necessitates procurement and construction of a meteorological tower that generally has an additional year of lead time. As the Commission explores the expanded use of off-site meteorological data in lieu of, or in addition to, onsite monitoring, we support efforts to align regulatory guidance with risk-informed, performance-based approaches that are consistent with modern reactor needs, technological capabilities, and legislative direction under the ADVANCE Act.

This letter focuses on ensuring that meteorological data requirements are appropriately tailored to the context of each facility and that the use of representative off-site data sources is clearly allowed under RG 1.23 when scientifically justified.

# 1. Importance of Meteorological Data and Regulatory Context

Meteorological data plays a critical role in ensuring that siting decisions, licensing evaluations, and emergency preparedness plans reflect the real-world conditions that affect public health and safety. Accurate weather data informs calculations of atmospheric dispersion and radiation dose under normal operation and accident scenarios, siting evaluations under 10 CFR Part 100 and NEPA reviews, emergency planning zones (EPZs) and offsite exposure modeling for protective action guidance.

Meteorological data is essential for modeling how radiation behaves in the environment, both for long-term planning and real-time emergency response. Without reliable meteorological input, these models and regulatory findings risk either overestimating or underestimating. This can result in unjustified licensing barriers or unrecognized public safety vulnerabilities. However, the value of meteorological data lies not in its format or collection method, but in its ability to accurately inform safety analyses. That is why the NRC must adopt a risk-informed, performance-based approach to its collection of meteorological data for siting, licensing, and emergency planning.

The corresponding NRC regulations appropriately require applicants to demonstrate that safety and environmental standards are met, but intentionally leave discretion as to how applicants generate the technical data. Guidance documents, such as Regulatory Guide (RG) 1.23, describe one acceptable method for meteorological data collection but are not binding requirements.

However, in practice, NRC guidance has come to be treated as de facto regulation by both staff and applicants, creating unnecessary procedural conservatism. The regulatory guidance has not been significantly updated because NRC still believes that collecting years of onsite data is one approach to meeting the regulations. Developers frequently default to installing on-site meteorological towers and collecting years of data, not because safety demands it, but because deviation from guidance is perceived as introducing regulatory uncertainty. The result is a growing divergence between the NRC's stated performance-based philosophy and its actual implementation culture.

Recognizing scientifically valid off-site meteorological data as an acceptable input for siting, licensing, and emergency preparedness is one of the most practical and impactful steps the agency can take to reinforce risk-informed decision-making. Onsite data collection remains appropriate in many circumstances when a plant is operational, but the agency should make clear that alternative, technically justified data sources are fully permissible under existing rules, especially before the facility enters operation.

Updating this guidance and providing reasonable and approved conversion methods for generally available alternative meteorological data sources is a relatively straightforward task.

## 2. Challenges with Current Meteorological Data Regulations

The NRC's current implementation of meteorological data requirements is overly prescriptive in *how* data must be collected, rather than focused on whether the data ultimately provides a sufficient basis to ensure public safety. The technical expectations reflected in Regulatory Guide (RG) 1.23 have, over time, become treated as de facto mandatory procedures rather than flexible guidance, inhibiting innovation and discouraging applicants from proposing alternative scientifically valid approaches. The staff often use the existing guidance as a baseline to test equivalency for alternative approaches, rather than considering whether an alternative meets the regulatory requirements.

At its core, RG 1.23 has a strong preference for long-term onsite meteorological monitoring, including installation of towers to collect wind speed, wind direction, and most critically, vertical temperature difference (delta-T) between two elevations; typically 10 meters and 60 meters above ground level. Delta-T serves as a surrogate for vertical atmospheric mixing and is used to derive Pasquill-Gifford stability classes, which are inputs for many of the NRC's legacy dispersion models (e.g., PAVAN, XOQDOQ, ARCON96).

RG 1.23 recommends minimum data collection periods of 12 months prior to construction permit (CP) applications and 24 months prior to operating license (OL) or combined license (COL) applications, with a general preference for at least three years of onsite data. These requirements reflect historical assumptions built around large light-water reactors, substantial offsite source terms, and limited access to high-quality alternative meteorological data sources. Regulatory Guide 1.23 was originally published in 1972.[1] At the time, access to high-quality alternative meteorological data was limited or unavailable, and collecting high-quality onsite data over 2-3 years was considered the minimum necessary to make regulatory decisions with acceptable levels of uncertainty.

In today's environment, these assumptions are increasingly outdated. High-quality offsite meteorological data from national networks (e.g., NOAA), state mesonets, and environmental monitoring stations often provide long-duration, rigorously validated datasets on wind conditions, cloud cover, solar radiation, precipitation, and temperature. All of which are parameters that can support alternative scientifically accepted methods for stability classification, such as the Turner method or solar radiation delta-T techniques used widely in environmental air quality modeling. These methods are well-established in other regulatory contexts (e.g., U.S. EPA) and can be applied in ways that are entirely consistent with NRC safety objectives when properly benchmarked.

RG 1.23 technically allows for the use of alternative data sources "if justified," but offers no detailed framework or acceptance criteria by which such justifications would be evaluated. As a result, both applicants and NRC staff have defaulted to treating onsite tower installation as the only "safe" path forward, despite the NRC's broader commitment to performance-based, risk-informed regulation.

This dynamic creates several unnecessary challenges:

- **Licensing delays and cost burdens**: Developers must often site and operate meteorological towers years ahead of license application submittal, even when alternative high-quality data already exists.

[1] Nuclear Regulatory Commission, "Onsite Meteorological Programs", Regulatory Guide 1.23, Rev. 0, February 17, 1972, ML020360030.

- **Disincentive for innovation**: Smaller developers, microreactor projects, and brownfield repowering sites face disproportionate challenges when prescriptive data collection expectations are imposed that may have no meaningful safety benefit.
- **Cultural conservatism**: NRC staff, lacking clear evaluative criteria for offsite data acceptance, are understandably risk-averse in their review practices, reinforcing the procedural conservatism that the agency's performance-based philosophy was intended to overcome.

The result is not a question of safety being compromised; Regulatory Guide 1.249 already permits the use of alternative weather information for calculating safety-related offsite dispersion of radioactive materials for design basis accidents. The issue is a regulatory bottleneck that slows deployment, raises costs, and discourages risk-informed innovation without improving public health protection. The long duration of these datasets reduces uncertainty for regulator decision-making relative to current guidance. The NRC's own staff has acknowledged in public meetings that clearer, performance-based acceptance pathways for alternative meteorological data would help address these challenges.

Expecting each applicant to provide bespoke, customized alternative approaches to evaluate and convert meteorological data to NRC expected formats, and then requiring NRC staff to evaluate dozens of different approaches, is the least efficient approach available. The function of guidance is to improve regulatory predictability and efficiency, but innovation has made the current guidance outdated.

## 3. Use of Offsite Data in Other Federal Regulatory Frameworks

The use of offsite meteorological data sources is already accepted practice in other federal regulatory contexts. Most notably, the U.S. Environmental Protection Agency (EPA) has long recognized that the value of meteorological data lies in its ability to represent the atmospheric conditions of interest, using both onsite and offsite meteorological data collection.

The EPA's air quality regulatory framework offers a strong precedent for performance-based use of offsite data. Models such as AERMOD and CALPUFF, used for permitting and environmental compliance under the Clean Air Act, routinely incorporate meteorological data from offsite sources, including National Weather Service (NWS) stations and state mesonets. These models are supported by EPA guidance. Specifically, *Appendix W to 40 CFR Part 51*[2] and the *Meteorological Monitoring Guidance for Regulatory Modeling Applications*[3] prioritize spatial and temporal representativeness over geographic proximity. In other words, meteorological data is considered acceptable if it accurately characterizes the atmospheric conditions at the site, regardless of whether it was collected onsite.

EPA guidance also recognizes that certain meteorological parameters are inherently regional in nature. Stability class, for example, can often be derived using the Turner method based on solar radiation and wind speed, without the need for vertical temperature measurements from an onsite tower. When gaps in data occur, the EPA allows for interpolation or substitution using representative sources, reinforcing a pragmatic approach focused on modeling integrity and public health protection.

These standards reflect a regulatory philosophy that is both flexible and scientifically rigorous that empowers regulators to use a range of data sources, provided their applicability is justified. The NRC should adopt a similarly pragmatic approach by clarifying that offsite meteorological data may be used to support siting, licensing, and emergency preparedness when representativeness can be reasonably demonstrated. Doing so would not only align NRC policy with other federal agencies, but would also reinforce the Commission's commitment to risk-informed, performance-based regulation as required under the ADVANCE Act.

## 4. Expanded Use of Offsite Meteorological Data at the NRC

The NRC's regulations require that applicants provide sufficient meteorological data to support safety and environmental analyses, but they do not prescribe how that data must be collected. Guidance documents, like RG 1.23, have historically defaulted to recommending multi-year onsite

[2] U.S. Environmental Protection Agency, *Appendix W to 40 CFR Part 51 — Guideline on Air Quality Models*, https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-51/appendix-Appendix%20W%20to%20Part%2051

[3] EPA-454/R-99-005

tower data as the primary means of satisfying this obligation. While technically allowed under existing rules, alternative approaches using offsite meteorological data sources are rarely pursued in practice due to regulatory uncertainty and a culture of procedural conservatism (namely NOAA stations, state mesonets, or other validated third-party systems).

NRC leadership should develop staff training and review guidance that supports a culture of openness toward alternative approaches, ensuring that developers are not deterred from proposing flexible, risk-informed strategies by fear of protracted review or inconsistency. These changes will help ensure that regulatory practices match the agency's stated risk-informed, performance-based philosophy and support efficient, safety-focused licensing decisions aligned with the ADVANCE Act.

In this context, we support the continued development of guidance that integrates flexibility without compromising rigor. We agree with NRC staff and other stakeholders that performance-based demonstrations of data quality and applicability are more meaningful than fixed infrastructure requirements. Where offsite data can be used to reliably characterize long-term atmospheric conditions, particularly in flat or uniform terrain, the requirement to install and operate a meteorological tower years in advance of licensing imposes unjustified cost and time burdens.

The NRC should make clear, through updates to RG 1.23 and related guidance, that offsite meteorological data sources are fully acceptable when they meet core performance-based criteria: spatial and temporal representativeness, data quality and resolution, and consistency with the assumptions of dispersion models used. These revisions would reinforce that guidance is not a binding regulation and encourage applicants to propose scientifically justified alternatives without fear of extended licensing delays. The NRC should also provide reasonable conversion methods for generally available meteorological data formats, such as NOAA data, to enable near-term applications to leverage alternative data and maximize review efficiency.

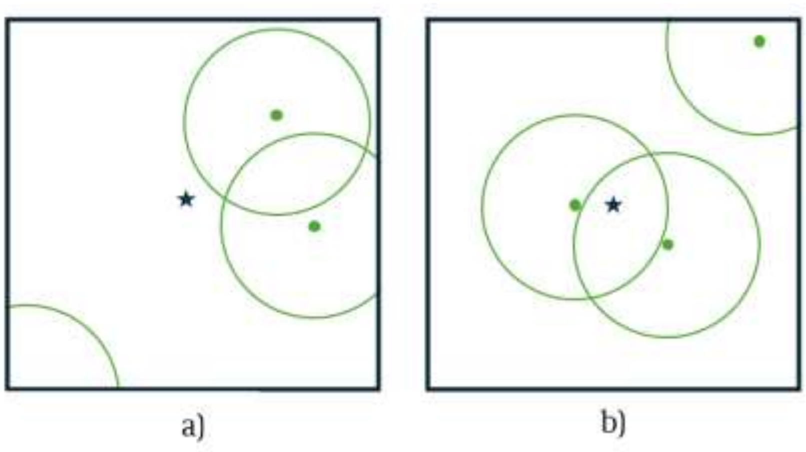


*Figure 1: Illustrative examples of two potential nuclear facility sites (stars), offsite meteorological data sources (points), and consistent radius from the data sources (circles).*

Providing guidance on conversion methods between data types, formats, and temporal representativeness is relatively straightforward and in most cases independent of site selection. Consistent guidance should be successful in enabling appropriate regulatory decision making that focuses on validation of information to result in reasonable assurance that the site is acceptable to meet the requirements to begin construction of a nuclear facility. However, determining spatial representativeness can be more challenging. This challenge did not need to be addressed in existing guidance due to the requirement of onsite meteorological data collection. While data collection is prevalent today, it does not fully cover every potential site. Figure 1 illustrates two potential sites and available offsite meteorological data collection sites. Circles depict a uniform radius from the collection source. Illustrative example (a) in the figure shows no data collection sources within a defined radius, whereas example (b) shows multiple overlapping sources within a certain radius. This variability relative to the availability of offsite data, relative to potential sites, makes it challenging to create a single set of guidance or method. The NRC should propose a method that would result in sufficient confidence for regulatory decision making, while also considering other options proposed by applicants.

A metric of robustness should be used to methodologically evaluate if a decision to allow the use of offsite meteorological data is robust when directly considering the inherent uncertainty. The existence of uncertainty is often considered to be a sufficient reason not to accept an alternative approach. However, the existence of uncertainty is only one component that should be considered in appropriate regulatory decision making, and must not be used as the sole reason for indecision or rejection. To be robust, a decision must be preferred even when the uncertainty is considered. In other words, if the regulatory decision would not change using the available offsite data with inherent uncertainty, instead of onsite data, then it is a robust choice. If the decision could, or is likely to change, then it is not robust.

## The Role of Bounding Analyses

Bounding analyses with alternative meteorological data are a viable approach to demonstrate that dispersion conditions are sufficiently protective of public health. Methodologies to use bounding analyses using definitive screening designs on validated models such as ARCON96 have been demonstrated.[4] A bounding approach is also consistent with current work at the NRC to further utilize Site Parameter Envelopes (SPE) for more efficient high-volume licensing of microreactors and low-consequence reactors. A simplified bounding approach may be especially appropriate to risk-inform early stages of licensing, including early site permit (ESP) applications or limited work authorizations (LWAs).

This approach is consistent with NRC's broader risk-informed framework and allows for progress on pre-construction milestones without compromising safety. As Adam Stein noted during the April 2025 NRC public meeting, bounding analyses using historical data from alternative sources can provide meaningful insight and avoid undue reliance on tower siting timelines that may not reflect actual radiological risk.

## Emergency Preparedness and Real-Time Operational Needs

While the use of reasonable offsite meteorological data should be allowed to support siting, licensing, and early construction activities, real-time onsite data remains essential for effective emergency response once a plant is operational. Emergency preparedness during operations—especially plume modeling and offsite response coordination—requires reliable, location-specific meteorological input to inform timely protective actions. However, the need for this data should

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[4] Biwalkar, Rohan, Kenneth Redus, Adam Stein, and Sola Talabi. 2023. "Estimation of Near-Field and Far-Field Post-Accident Atmospheric Dispersion for Microreactors." Nuclear Science and Engineering 197 (8): 2099–2116. doi:10.1080/00295639.2023.2204174.

be evaluated in the context of each plant's source term, siting characteristics, and emergency planning zone (EPZ).

Meteorological data needs should scale with risk. For reactors with a site-boundary EPZ and minimal offsite dose potential, real-time data needs may be substantially lower. In such cases, regulatory expectations should allow for flexibility, such as the use of off-the-shelf local wind sensors for plume direction and regional NOAA data for atmospheric stability, rather than mandating a full-scale met tower with multi-year datasets.

Offsite data may not be sufficient throughout the entire plant lifecycle. For operational plants with a larger than site boundary EPZ and potential offsite emergency response, the direction, speed, and stability of the local atmosphere must be understood in real time and at the point of origin. Regional data from NOAA or mesonet stations—even those just a few miles away—may not capture localized wind conditions affected by terrain, elevation, or microclimate patterns.

The NRC's emergency response tools, such as RASCAL,[5] were designed to process single-point real-time data from onsite towers. While these tools can pull data from regional data sources and infer weather patterns, local terrain (e.g., localized wind directions in a river valley) cannot always be effectively accounted for.

The NRC should consider separating key meteorological parameters (such as atmospheric stability class and wind direction/speed) in determining what must be collected onsite versus what may be inferred from offsite sources. As we relayed in the April 2025 public meeting, it is often feasible to infer regional stability, while localized wind conditions (especially in complex terrain) may still benefit from minimal local instrumentation at the lower 10-meter level. High-resolution equipment has become commercially available at low cost and could even be mounted to a mobile microreactor housing on an extendible mast.

[5] Radiological Assessment System for Consequence Analysis for radiological emergencies. The RASCAL code is a tool used by the Protective Measures Team in the NRCs Operations Center for making independent dose and consequence projections during radiological incidents and emergencies. See, https://ramp.nrc-gateway.gov/codes/rascal

Distinction of changing data requirements relative to risk preserves flexibility in the front end of the project while ensuring that safety-critical functions are met during reactor operation.

### Phased Approach and Pre-Operational Flexibility

A phased, performance-based approach is logical and consistent with public safety. A phased approach would allow:

- No requirement for full meteorological towers during the construction phase when no public health risk exists;
- Use of offsite meteorological data or bounding analyses to the extent practical for licensing decisions;
- Installation of local instrumentation, as needed, before reactor operation for EP support.

This would help address one of the most commonly cited critical path issues in advanced reactor licensing: having to establish a met tower and collect years of data before submitting an application. This issue has been raised repeatedly by developers and task forces, and resolving it aligns with the intent of the ADVANCE Act and Executive Orders focused on deployment efficiency.

## 5. ADVANCE Act Alignment

The meteorological data requirements applied to nuclear reactor siting must be reconsidered in light of the statutory directives set forth in the ADVANCE Act of 2024.[6] Congress enacted the ADVANCE Act with the clear purpose of removing regulatory barriers to enable the deployment of advanced nuclear technologies, modernize the NRC's regulatory framework, and allow the United States to realize the societal benefits of expanded nuclear energy deployment.

Several provisions of the ADVANCE Act, specifically Sections 206, 207, 208, and 505, reinforce the importance of enabling more efficient, risk-informed siting and licensing practices:

[6] Public Law No: 118-22.

- **Section 206** calls on the NRC to support the use of brownfield sites and repowered facilities, where meteorological data may already exist from prior operations or nearby infrastructure.
- **Section 207** directs expedited consideration of combined license (COL) applications, encouraging the Commission to streamline reviews where site-specific risks are demonstrably low.
- **Section 208** recognizes the unique siting needs of microreactors, where rigid meteorological monitoring requirements may be disproportionate to the source term.
- **Section 505** emphasizes the need for greater efficiency in reviews, explicitly citing the value of existing data sources and modern methods to reduce regulatory delays.

These provisions, taken together, support an approach in which meteorological data collection and use are scaled to the characteristics of the reactor, the site, and the potential public health impacts rather than defined by a one-size-fits-all mandate for onsite towers with multiple years of data.

## 6. Recommendations

The NRC's current approach to meteorological data collection has not kept pace with advances in environmental modeling, data accessibility, and reactor safety design. These outdated expectations introduce unnecessary costs and licensing delays, especially for advanced reactors.

To support the goals of the ADVANCE Act and align with the NRC's updated mission to enable the safe and secure use of nuclear technologies for the benefit of society and the environment, BTI recommends several key reforms to meteorological data regulations and guidance. Our recommendations seek to ensure that meteorological data requirements reflect modern capabilities, differentiate between licensing and operational needs, and empower applicants to use scientifically valid offsite data where appropriate.

## Modernize RG 1.23 to Support Alternative Data Sources and Flexible Collection Methods

RG 1.23 currently implies a one-size-fits-all approach to meteorological monitoring by emphasizing delta-T-based stability classification and recommending 12-24 months of continuous onsite data collection. This framework lacks performance-based acceptance criteria for alternative sources and fails to acknowledge that meteorological conditions can often be reliably characterized using high-quality offsite data from NOAA, mesonets, or other validated systems.

The NRC should revise RG 1.23 to support use of validated offsite data sources, allow bounding analyses where applicable, and support phased instrumentation strategies for pre-operational and operational phases. These updates would encourage innovation, reduce licensing barriers, and reinforce that guidance is intended to be flexible.

## RG 1.249: ARCON Methodology for Offsite Dispersion

The guide's current language may inadvertently discourage appropriate use of offsite data even when consistent with model assumptions. The NRC must clarify that offsite data sources may be used for ARCON modeling if spatial and temporal representativeness can be demonstrated.

Note that the ARCON code has been retired, but this guidance document has not been revised. Revision of this guidance should take minimal effort and would reduce confusion for new applicants, as this guidance is relevant to near-field consequence analysis in addition to implementation of the ADVANCE Act as discussed herein.

## Emergency Preparedness for SMRs and Non-LWRs

Applicants may lack clarity on how to justify offsite data use in EPZ establishment and real-time response systems. The NRC should update RG 1.242 to include examples where offsite data or minimal local instrumentation is acceptable under the performance objectives of 10 CFR 50.160.

RG 1.242 should distinguish between the meteorological data needs for early planning versus emergency response. During the licensing phase, offsite data sources should be explicitly recognized as acceptable for defining EPZ boundaries and developing emergency plans, particularly for reactors with minimal offsite dose potential. However, once a reactor enters operation, real-time emergency response functions (such as plume modeling, public warning, and coordination with offsite response organizations) require accurate, site-specific meteorological data. BTI supports maintaining onsite instrumentation requirements for these functions, especially in locations where terrain, elevation, or microclimate effects could cause significant deviation between onsite and regional weather patterns. Onsite meteorological conditions can influence near-field effects such as plume direction, building wake effects, plume meander, and plume rise.

The updated guidance should affirm that minimal onsite instrumentation, such as a 10-meter tower equipped for wind direction and speed, may be sufficient for many small reactors with site-boundary EPZs. However, this flexibility must be grounded in a risk-informed assessment of the reactor's potential for offsite release and the need for timely, accurate emergency decision-making. Ensuring real-time data is available at the point of origin remains a cornerstone of effective public safety management during reactor operation.

- **RG 4.2: Preparation of Environmental Reports for Nuclear Power Stations**

RG 4.2 outlines NEPA submission requirements, including meteorological data to support environmental impact assessments. Current language implies a preference for onsite data but does not fully embrace performance-based alternatives. RG 4.2 should explicitly permit the use of public meteorological datasets when they are demonstrated to be representative and reliable for NEPA purposes. This will ensure that applicants are not required to duplicate data collection efforts where high-quality, long-term public data is already available and scientifically valid.

## 7. Conclusion

The NRC has a unique opportunity, and a clear statutory direction under the ADVANCE Act, to modernize its approach to meteorological data requirements in reactor siting, licensing, and emergency preparedness. As detailed in this letter, current guidance was developed for legacy technologies and does not fully reflect the safety cases or deployment realities of advanced nuclear reactors. These rigid expectations risk imposing unnecessary costs and delays without corresponding safety benefits. Updating regulatory guidance to clearly support risk-informed, performance-based use of alternative data sources to enable the safe use of civilian nuclear energy will reinforce the NRC's commitment to flexibility and innovation.

BTI appreciates the NRC's engagement on this important issue and looks forward to supporting the agency's efforts to implement the ADVANCE Act and the recent Executive Orders while upholding public health, safety, and the promise of a clean energy future.

Sincerely,

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