Verification Statement

ADS Arcadia Hydrodynamic Separator
Registration number: V-2026-06-01
Date of issue: 2026-June-09

Technology type	Hydrodynamic Separator (HDS)	
Application	Technology to remove sediment, trash and debris from stormwater and snowmelt runoff as well as other pollutants that attach to sediment particles, such as nutrients and metals	
Company	Advanced Drainage Systems, Inc. (ADS)	
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Verified Performance Claims

ADS engaged Centre des technologies de l’eau (Cteau), Quebec, Canada to conduct third-party performance testing of the company’s Arcadia HDS technology based on the *“Canadian Publicly Available Specification (PAS) for Testing and Verification of Oil and Grit Separators (OGS)”* version June 2023 (Canadian OGS PAS) prepared by the Toronto and Region Conservation Authority (TRCA), Ontario, Canada. The performance test results for the ADS Arcadia HDS technology were verified by TRCA following the requirements of the International Organization for Standardization *“ISO 14034:2016 Environmental management - Environmental technology verification (ETV)”* standard, the VerifiGlobal Performance Verification Protocol, and the ADS Arcadia HDS ISO 14034 ETV Verification Plan. The following performance claims were verified:

Capture test[1]:
With a false floor set to 50% of the manufacturer’s recommended maximum sediment storage depth and an influent test sediment concentration of 200 mg/L, the Arcadia HDS device removes 81.4, 68.5, 64.4, 61.1, 55.4, 52.2, and 45.4 percent of influent sediment by mass at surface loading rates of 40, 80, 200, 400, 600, 1000, and 1400 L/min/m^2, respectively.

Scour test[1]:
With test sediment preloaded onto a false floor reaching 50.7% of the manufacturer’s recommended maximum sediment storage depth, the Arcadia HDS device generates corrected effluent concentrations of 0.4, 1.4, 13.3, 26.1, and 43.5 mg/L at 5-minute duration surface loading rates of 200, 800, 1400, 2000, and 2600 L/min/m^2, respectively.

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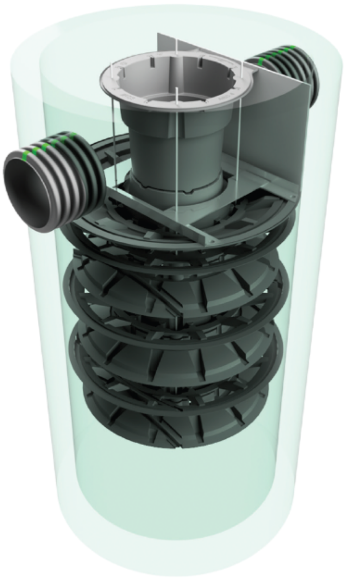
[1] The claims can be applied to other units smaller or larger than the tested unit as long as the untested units meet the scaling rule specified in the Canadian PAS for Testing and Verification of OGS (version June 2023).

Technology Application

The Advanced Drainage Systems (ADS) Arcadia^{TM} Hydrodynamic Separator (HDS) is a stormwater treatment device that removes suspended solids from stormwater. The ADS Arcadia HDS offers a compact treatment solution in places where pollutants, sediment, trash, debris, and nutrients are of concern. The internal components, molded from either polyethylene or polypropylene, can be typically installed in either a precast concrete manhole or a polypropylene manhole.

Technology Description

In the Arcadia HDS unit, stormwater is directed to an inlet chamber, which then directs the flow into the vertical cylinder. The inlet and outlet pipes are at the same elevation. A weir separates the inlet chamber from the outlet chamber. Once water has flowed through the inlet chamber and down through the vertical cylinder to the sump, the water rises through a series of angled baffles up to the outlet pipe. The angled baffles have concentric openings, alternating in location between the outer wall and the vertical cylinder, causing the water to flow upward in a circuitous path, which enhances settling and reduces resuspension. The inlet chamber is equipped with a sediment drain opening that directs sediment into the sump during operation. Figure 1 provides a summary of Arcadia HDS features.



Features

- *Single manhole design*
- *No elevation loss between the inlet and outlet*
- *Variable inlet/outlet angle configurations (not just 180-degree orientation)*
- *Internal bypass for online installation (where applicable)*
- *Innovative, patent-pending design mitigates turbulence in the sump area to prevent resuspension of captured contaminants*

Figure 1 – ADS Arcadia HDS

ADS possesses full ownership of the Arcadia HDS technology, and it is commercially available. The Arcadia HDS patent is pending.

Description of Test Procedure

The test unit was a full-scale commercially available Arcadia^{TM} AR4HP unit (4 ft diameter), with the same configuration and components as would be used in an actual installation. Influent and effluent piping to the Arcadia unit were 12-inches in diameter and at the same inlet/outlet elevations. The test unit had an effective treatment area (ETA) of 1.167 m^2. For removal efficiency testing, the false floor was set to allow for simulation of the 50% maximum sediment storage volume. For scour testing, the false floor was set to allow for four inches of sediment to be pre-loaded to the 50% maximum sediment storage volume. Figure 2 provides a profile view of the Arcadia HDS test unit, including false floor positions. Figure 3 provides a plan view of the Arcadia HDS. The same unit was used for sediment removal, hydraulic testing, and sediment scour testing.

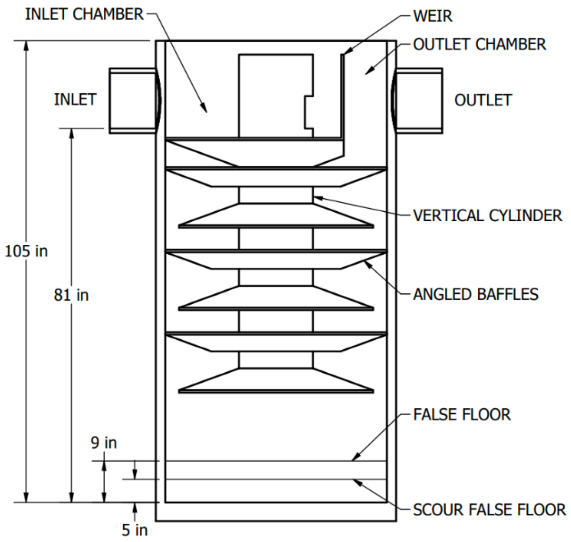


Figure 2 - Profile View of the Arcadia Test Unit, Including False Floor Positions

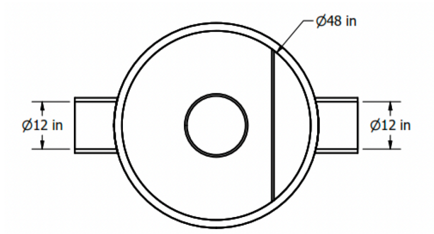


Figure 3 – Arcadia Plan View

Verification Results

TRCA verified the performance test data and other information pertaining to the ADS Arcadia HDS. A Verification Plan was prepared to guide the verification process based on the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol.

Test Sediment

The test sediment consisted of ground silica (1 – 1000 µm) with a specific gravity of 2.65, uniformly mixed to meet the particle size distribution (PSD) specified in the testing procedure. The Canadian OGS PAS current at the time of testing required that the test sediment batch be separated into individual batches for use in testing at each of the minimum 7 required surface loading rates (SLRs) for the sediment removal test and for preloading (minimum 1) during the sediment scour and resuspension test. Samples of sediment from each individual test run batch were collected and analyzed for PSD in accordance with ASTM D6913-17 and ASTM D7928.

The average PSD exceeded the +/-3% tolerance at two particle size ranges, including a consistent deficit in the fine particle fraction (5–8 µm) and a minor deviation in the coarse range (250–500 µm). All individual sediment removal test samples exceeded the +/-5% tolerance in the fine fraction but were within +/-5% at other sizes. The median particle size of the average and all individual samples was under 75 µm. Comparison of the individual samples to the specified PSD (Figure 4) confirms that, while the ±5% tolerance was not met in the fine particle fraction, all samples satisfied the median particle size requirement.

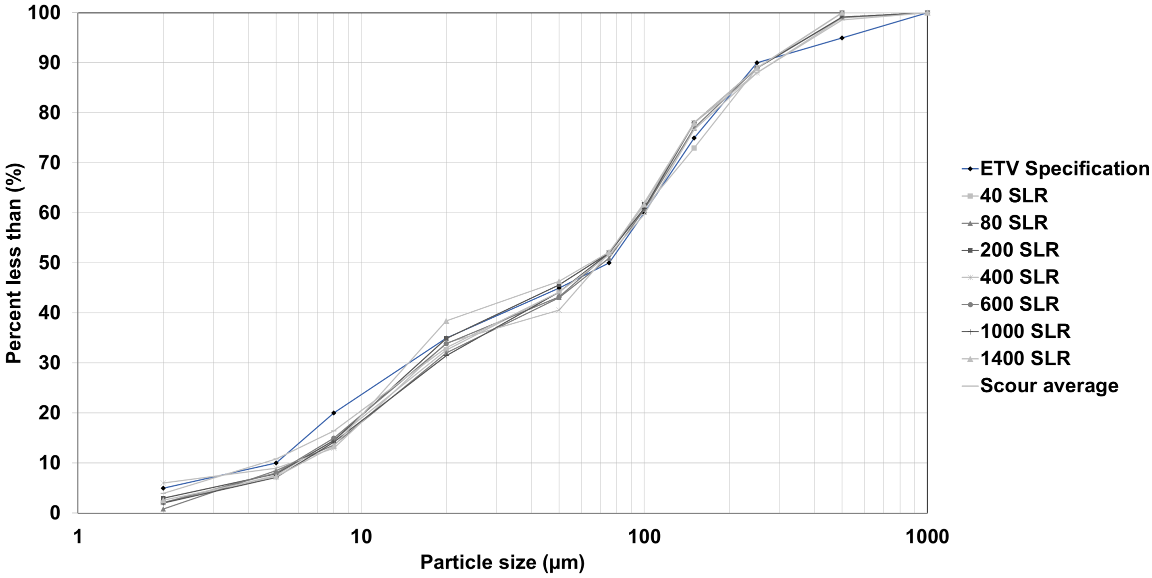


Figure 4 - PSD of the test sediments used for the capture and scour tests compared to the ETV test sediment specification

Sediment Removal Testing

The capacity of the device to retain sediment was determined at seven SLRs using the modified mass balance method. This method involved measuring the mass and PSD of the injected and retained sediment for each test run. Performance was evaluated with a false floor simulating the technology filled to 50% of the manufacturer's recommended maximum sediment storage depth. The test was carried out with clean water that maintained a sediment concentration below 20 mg/L. Based on these conditions, removal efficiencies for individual particle size classes and for the total mass injected and retained by the unit were determined for each of the tested SLRs.

The Canadian OGS PAS requires all areas with significant sediment accumulation to be measured separately. Removal efficiencies are based on sediment retained within the HDS. Sediment distribution within the system, including the inlet pipe and internal treatment zones, is summarized in Table 1. Sediment retained within the HDS is reported as a combined value for the sump and internal settling zones (e.g., baffles). Sediment retained in the inlet pipe was minimal across all test conditions and is reported separately.

Parameter	Surface Loading Rate (L/min/m2)						
	40	80	200	400	600	1000	1400
Influent sediment mass (kg)	11.4	11.4	11.6	12.6	11.9	13.1	14.4
Retained sediment mass (sump + baffles) (kg)	9.3	7.8	7.4	7.7	6.6	6.8	6.5
Inlet pipe (kg)	0.031	0.026	0.011	0.005	0.011	0.015	0.000
Removal efficiency	81.4%	68.5%	64.4%	61.1%	55.4%	52.2%	45.4%

Table 1 - Distribution of retained sediment by location at specified surface loading rates

While a minor amount of sediment was retained in the inlet pipe during testing, a significant proportion of sediment was retained outside the primary sump, with the majority observed on internal baffle surfaces under all test conditions. This distribution of retained sediment may influence sediment removal and resuspension behaviour and should be considered when interpreting both sediment removal and scour test results, as well as in the context of inspection and maintenance practices.

Not all retained sediment was included in PSD analysis, as sediment recovered during the decantation (filter bag) process was excluded. This material represented approximately 4% to 25% of the total retained mass depending on the test condition. For some tests, sediments from baffles 1 to 7 were combined with the sump sediment to create a composite sample. This approach captured all settled sediment in the internal system and allowed accurate calculation of overall removal efficiency.

In some instances, the removal efficiencies were above 100% for certain particle size fractions. These discrepancies are not unique to any one test laboratory and are attributed to errors relating to the blending and disaggregation of retained sediment, collection of representative samples for laboratory submission, and laboratory analysis of PSD. Due to these errors, caution should be exercised in applying the removal efficiencies by particle size fraction for the purposes of sizing the tested device. Removal efficiencies by particle size are subject to increased uncertainty due to incomplete PSD characterization of retained sediment. The results for all particle sizes by mass balance in Table 2 are based on measurements of the total injected and retained sediment mass that was analysed for PSD, and are therefore not subject to blending, sampling or PSD analysis errors.

Particle Range (µm)	Surface Loading Rate (L/min/m 2)						
	40	80	200	400	600	1000	1400
>500	-[1]	51	50	100[2]	-[1]	77	-[1]
250-500	100[2]	100[2]	89	93	100[2]	100[2]	98
150-250	99	90	95	85	100[2]	92	80
100-150	100[2]	92	91	86	90	86	70
75-100	100[2]	73	79	77	90	60	42
50-75	72	69	75	48	41	33	36
20-50	34	13	15	52	6	11	10
8-20	31	4	5	6	2	2	1
5-8	14	2	1	4	0	1	1
<5	6	0	0	5	2	3	1

[1]For the 40, 600, and 1400 L/min/m² SLRs, the influent particle size distribution indicated 100% passing at 500 µm, resulting in a zero calculated fraction for particles greater than 500 µm. As a result, removal for this size range could not be calculated.
[2]Removal rates were calculated to be above 100%.
[3]Mass balance removal is based on total retained sediment mass (including sump, supernatant, and all recovered fractions) and is not directly comparable to PSD-based size-specific removal values.

Table 2 - Removal efficiencies (%) of the Arcadia HDS at specified surface loading rates

Figure 5 compares the PSD of the average of the test sediment samples to the PSD of the sediment retained by the ADS Arcadia HDS at each of the tested SLRs. The capture efficiency for fine particles was generally found to decrease as SLRs increased.

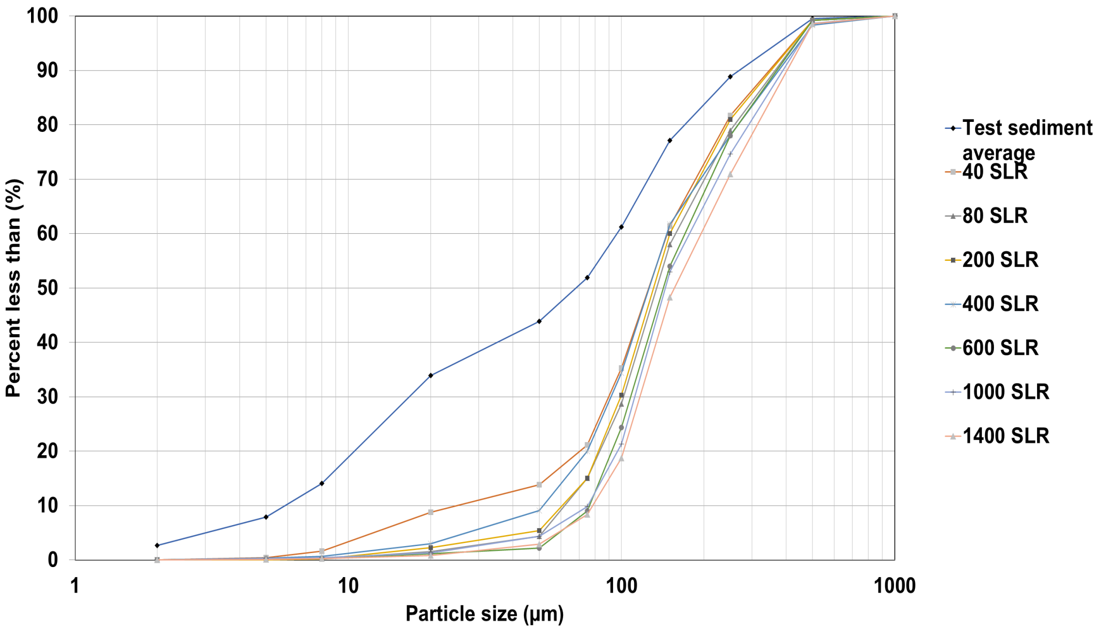


Figure 5 - Particle size distribution of sediment retained in the ADS Arcadia HDS in relation to the injected test sediment average

Sediment Scour Testing

Table 2 shows the results of the sediment scour and re-suspension test for the Arcadia HDS. The Canadian OGS PAS requires that areas with significant sediment accumulation outside of the sump are pre-loaded with sediment but various attempts to pre-load Baffle 7 were unsuccessful without lab intervention. Therefore, instead of preloading Baffle 7 for this test, the false floor was set 4 inches (10.2 cm) below the 50% storage depth. The space above the false floor was then filled with the required uniform 4-inch (10.2 cm) thick sediment layer to reach the 50% storage capacity. An additional 6.2 kg of sediment, corresponding to the Baffle 7 mass from the 40 SLR condition, was subsequently placed above this sediment layer, resulting in a total final sediment layer depth of 10.5 cm (50.7% storage capacity).

Clean water was run through the device at five SLRs over a 30-minute period. Each flow rate was maintained for 5 minutes with a one-minute transition time between flow rates. Effluent samples were collected at one minute sampling intervals and analyzed for suspended sediment concentration and PSD by methods specified in the Canadian OGS PAS. The measured d_5 was 13.7 µm; however, as this exceeds the maximum allowable value of 10 µm specified in the Canadian OGS PAS, a value of 10 µm was used for the d5 correction. Adjustments also accounted for background concentrations at each SLR. The adjusted effluent data is shown in Table 3. Results showed increasing effluent sediment concentrations with increasing SLR, reaching a maximum adjusted concentration of 43.5 mg/L.

Run	Target SLR (L/min/m²)	Run time (min)	Initial averaged effluent suspended solids concentration (mg/L)	Average adjusted effluent suspended sediment concentration (mg/L)[1]
1	**200**	1:00 - 6:00	3.4	0.4
2	**800**	7:00 - 12:00	4.4	1.4
3	**1400**	13:00 - 18:00	50.6	13.3
4	**2000**	19:00 - 24:00	63.4	26.1
5	**2600**	25:00 - 30:00	87.4	43.5

[1] The effluent suspended sediment concentration is adjusted based on the background concentration of feed water and the d_5 correction using the maximum 10 microns.

Table 3 - Scour test adjusted effluent sediment concentration at each surface loading rate

As noted above, not all retained sediment was analyzed for PSD. In the 40 SLR sediment removal test, used to determine the d5 correction, 0.388 g were omitted from PSD analysis. Given its relatively small contribution (4%) to the overall PSD-weighted mass, and that it likely consisted of a mixture of supernatant and sump sediment the impact on d5 is expected to be minor and the maximum allowable 10 um was used for the d5 correction.

It is noted that a substantial proportion of sediment was retained outside the primary sump during testing, with the majority observed on internal baffle surfaces. This distribution may influence sediment removal and resuspension behaviour and should be considered in the context of inspection and maintenance practices to ensure sustained performance.

Quality Assurance

Performance testing and verification of the Arcadia HDS were performed in accordance with the requirements of ISO 14034:2016 and the VerifiGlobal Performance Verification Protocol. In addition, the Canadian OGS PAS specifies QA/QC requirements to ensure that results are accurate and precise, including use of certified laboratories, established test methods, calibrated equipment, tolerance limits for variations in test results, data checks, and stringent documentation.

The verifier, TRCA, has reviewed and confirmed that the key QA/QC requirements were addressed throughout performance testing and the generation of test results for the Arcadia HDS. This included reviewing all data sheets and data downloads, as well as overall management of the test system, quality control and data integrity. Table 3 summarizes the key QA/QC parameters and acceptance criteria for Arcadia HDS technology performance testing and verification.

QA/QC Parameters	Acceptance Criteria
Particle Size Distribution	Analyzed by a certified laboratory in accordance with ASTM D6913-17 and ASTM D7928. Percentages for size ranges vary by <5%, median < 75 um. PSD in water determined by ISO 13320 (2020) Particle Size Analysis – Laser Diffraction Methods.
Solids in test water	Suspended solids concentration of test water of < 20 mg/L using ASTM D3977-97 (2019) Standard Test Methods for Determining Sediment Concentration in Water Samples.
Water temperature	Temperature of water less than 25°C.
Flow measurement equipment	Equipment calibration reports submitted to confirm that reported flow rate matches actual flow rate.
Flow rate variation	Flow rates have COV < 0.04; maintained with 10% of target flow rate for CETV target flow rates.
Sediment feed	Total suspended solids concentration target = 200 mg/L with a tolerance limit of ±25 mg/L. Injection location is 0.91 m upstream of inlet to the device, as per the Canadian OGS PAS. At least six feed rate calibration samples taken over duration of each test run.
Sediment moisture content	Determined by ASTM D2216 (2019), Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
Sample analysis	Conducted by qualified laboratories using standard methods and meeting the requirements of ISO 14034 and ISO 17025.

Table 3. Summary QA/QC parameters and acceptance criteria for Arcadia HDS technology performance testing and verification

Variances from the Canadian OGS PAS

Some minor deviations from the prescribed Canadian OGS PAS test procedure were observed, including brief flow exceedances, short intervals of missing flow data, and influent total suspended solids concentrations exceeding target ranges. Additional deviations included sediment handling differences, incomplete PSD analysis of a portion of retained material, and modified scour test preloading procedures as noted below.

All these deviations were either limited in extent or conservative with respect to sediment retention performance and are not considered to bias the Arcadia HDS test results. Accordingly, they have been reviewed and accepted as documented variances by the verifier.

1. Sediment handling differences - For some tests, sediments from Baffles 1–7 were combined with the sump sediment to create a composite sample. This approach captured all settled sediment in the internal system and allowed accurate calculation of overall removal efficiency.

2. Incomplete PSD analysis of a portion of retained material - Sediment recovered during the decantation (filter bag) process was excluded from PSD analysis. This material contained sediment originating from both the supernatant and the sump, representing approximately 4% to 25% of the total retained mass, depending on the test condition. This limitation was accepted, as removal efficiencies based on total mass balance were determined using the full retained sediment mass and are not affected by this omission.

3. Modified scour test preloading procedures - Based on sediment removal test results, approximately 67% of the retained sediment accumulated on Baffle 7, while Baffles 1–6 and the inlet pipe each retained less than 5% and did not require preloading. Although attempts were made to preload Baffle 7, sediment could not be stably retained and rapidly migrated into the sump at the onset of flow. Retaining sediment on this would have required artificial intervention, which was considered outside the scope and intent of the Canadian OGS PAS and not representative of in field accumulation processes. Baffle 7 was therefore treated as a transition zone under scour test conditions. Instead, the associated sediment mass was added to the sump preloading to conservatively represent total retained sediment. This variance does not impact the validity or intent of the scour test.

Verification Summary

In summary, the Hydro Arcadia ® HDS is a viable technology that, when sized appropriately, can be used to capture and retain sediment and associated pollutants from stormwater runoff.

Table 4 summarizes the verification results in relation to the technology performance parameters that were identified to determine the efficacy of the Hydro Arcadia ® HDS.

Performance Parameter	Verified Performance
Sediment Removal Rate	The sediment removal rate of the ADS Arcadia HDS is dependent upon flow rate, particle density and particle size. Removal efficiencies varied between 45.4% at a SLR of 1400 L/min/m^2 to 81.4% at a SLR of 40 L/min/m^2. The weighted average removal efficiency achieved by the unit will vary depending on the rainfall distribution of the jurisdiction in which it is installed, and site characteristics.
Sediment Scour	When pre-loaded with sediment with a PSD matching that of the feed sediment used in the sediment capture test, the ADS Arcadia HDS generated effluent suspended solids concentrations of less than 43.5 mg/L at SLRs ranging from 200 to 2600 L/min/m^2.
Bypass Flow Rate	Bypass occurred only at flow rates exceeding 2,600 L/min, which is above the range of flow rates typically evaluated for performance.
Head Loss	The loss of hydraulic head across the unit was determined by measuring the water elevation difference between the inlet and outlet sides of the insert. Head loss may vary based on model size. Hydraulic testing was conducted at flows ranging from 0 to 56.57 L/sec. The maximum calculated loss was 0.28m at 50.57 L/sec.

Table 4 - Summary of verification results against performance parameters

What is ISO 14034?

The purpose of environmental technology verification is to provide a credible and impartial account of the performance of environmental technologies. Environmental technology verification is based on a number of principles to ensure that verifications are performed and reported accurately, clearly, unambiguously and objectively. The International Organization for Standardization (ISO) standard for environmental technology verification (ETV) is ISO 14034, which was published in November 2016.

Benefits of ETV

ETV contributes to protection and conservation of the environment by promoting and facilitating market uptake of innovative environmental technologies, especially those that perform better than relevant alternatives. ETV is particularly applicable to those environmental technologies whose innovative features or performance cannot be fully assessed using existing standards. Through the provision of objective evidence, ETV provides an independent and impartial confirmation of the performance of an environmental technology based on reliable test data. ETV aims to strengthen the credibility of new, innovative technologies by supporting informed decision-making among interested parties.

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