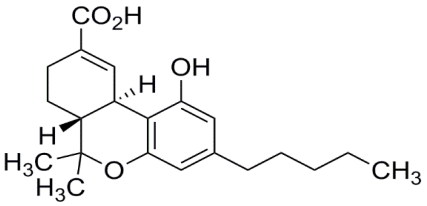
Certified Reference Material - Certificate of Analysis

(-)-11-nor-9-Carboxy-Δ^9-THC, Primary Measurement Standard

6a,7,8,10a-tetrahydro-6,6-dimethyl-3-(pentyl)-6H-dibenzo[b,d]pyran-9-carboxylic acid

Product No.: T-018-1ML
Lot No.: FN06142422
Description of CRM: (-)-11-nor-9-Carboxy-Δ^9-THC in Methanol (Solution)
Expiration Date: June 2030 See Stability Section
Storage: Store unopened in freezer (-10 °C to -25 °C).
Shipping: Ambient. See Stability Section
Chemical formula: $C_{21}H_{28}O_4$
CAS No.: 56354-06-4
Regulatory: Canadian TK # 61-1547



Analyte	Certified Concentration ± associated uncertainty U, $u = k * u$ ($k = 2$)
(-)-11-nor-9-Carboxy-Δ^9-THC	**100.0 ± 0.6 µg/mL**

Metrological traceability: Traceable to the SI and higher order standards from NIST through an unbroken chain of comparisons. See "Details on metrological traceability" on page 3.

Measurement method: The certified value is calculated from high precision weighing of thoroughly characterized starting material. See "Details about certification process" on page 3.

Intended use: This Certified Reference Material is suitable for the in vitro identification, calibration, and quantification of the analyte(s) in analytical and R&D applications. Not suitable for human or animal consumption.

Minimum sample size: 1 µL for quantitative applications

Instructions for handling and correct use: Concentration is corrected for chromatographic purity, residual water, residual solvents, and residual inorganics. No adjustment required before use.

Users should quantitatively transfer desired volume using established good laboratory practices to spike into matrix or to dilute to the desired concentration. Each ampoule is intended for one-time use.

Health and safety information: Danger. Please refer to the Safety Data Sheet for detailed information about the nature of any hazard and appropriate precautions to be taken.

Accreditation: Cerilliant Corp. is accredited by the US accreditation authority ANAB as registered reference material producer AR-1353 in accordance with ISO 17034 and registered testing laboratory AT-1352 according to ISO/IEC 17025.

ANAB
ANSI National Accreditation Board
ACCREDITED
ISO 17034
REFERENCE MATERIAL PRODUCER

James Schmitt, Quality Assurance Manager

August 05, 2025
Issue Date

Cerilliant Corporation, 811 Paloma Drive, Round Rock, TX, 78665, USA,
Tel: 800-848-7837 / 512-238-9974; www.cerilliant.com
Sigma-Aldrich Production GmbH is a subsidiary of Merck KGaA, Darmstadt, Germany.

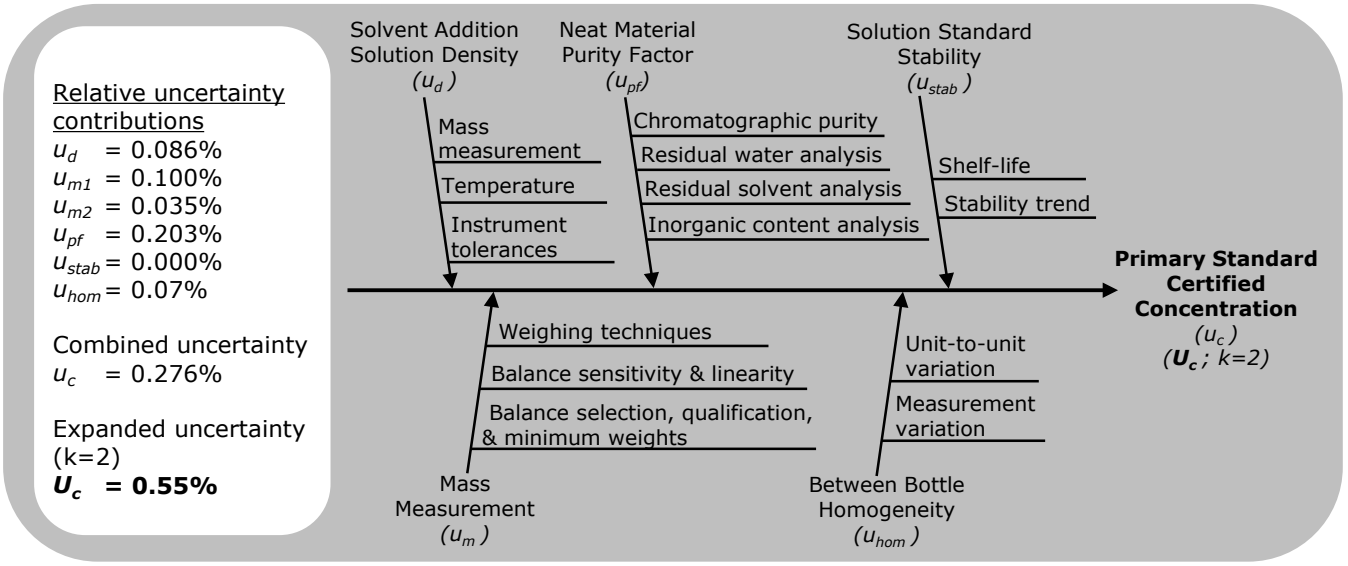
Packaging: 2 mL amber USP Type 1 glass ampoule containing not less than 1 mL of certified solution. Ampoules are overfilled to ensure a minimum of 1 mL volume can be transferred when using a 1mL Class A volumetric pipette.

Details on starting materials: Each raw material utilized has been identified and thoroughly characterized through the use of multiple analytical techniques and is assigned a Purity Factor by Mass Balance or QNMR. Spectral data is provided on subsequent pages of this CoA.

Certificate of Origin: Cerilliant Corporation certifies no material of animal origin (BSE/TSE) was used in the preparation of this product.

Country of Origin: United States of America

Associated uncertainty:
The uncertainty has been calculated by statistical analysis of all aspects of our production system and incorporated uncertainty of the purity factor, material density, balance, weighing technique, and homogeneity. Uncertainty components of the gravimetrically prepared Primary Standard concentration are shown in the figure below. Uncertainty is expressed as an expanded uncertainty in accordance with ISO 17034 at the approximate 95% confidence interval using a coverage factor of k=2. Uncertainty contribution from neat material homogeneity was established to be negligible through establishment of process controls and verification of the control process. Stability uncertainty was determined to be negligible by regression analysis.



Details on metrological traceability:

- This standard has been gravimetrically prepared using balances that have been fully qualified and calibrated to ISO 17025 requirements. All calibrations utilize NIST traceable weights which are calibrated externally by a qualified ISO 17025 accredited calibration laboratory to NIST standards. Qualification of each balance includes the assignment of a minimum weighing by a qualified and ISO 17025 accredited calibration vendor taking into consideration the balance and installed environmental conditions to ensure compliance with USP tolerances of NMT 0.10% relative error.
- Fill volume to predetermined specifications is gravimetrically verified throughout the dispensing process using qualified and calibrated balances.
- The density and material Purity Factor of each raw material is traceable to the SI and higher order reference materials through mass measurement and instrument qualification and calibrations.

Details about certification process:

This standard has been prepared and certified under the ISO 17034, ISO/IEC 17025, and ISO 9001 standards. This standard meets the requirements of a Certified Reference Material and a Primary Standard as defined by ISO and is traceable to the SI and higher order standards through an unbroken chain of comparisons.

- Nominal concentration is calculated based on: the actual mass; Purity factor of the analyte(s); measured mass of the solution; and the density of the pure diluent at 20°C.
- Fill volume is gravimetrically verified throughout the dispensing process using qualified and calibrated balances.
- Concentration is verified against an independently prepared calibration solution gravimetrically prepared.
- Additional certification information available upon request.

Solution Standard Verification

Concentration accuracy and within- and between-bottle homogeneity are analytically verified against an independently prepared calibration solution and to the prior lot.

Standard Solution Assay Parameters		**Calibration Curve**	
Analysis Method:	HPLC/UV	**Calibration Curve:**	Linear Regression
Column:	Ascentis Express C18, 2.7 µm, 3.0 x 50 mm	**Number of Points:**	4
Mobile Phase:	Acetonitrile:0.1% Phosphoric acid in Water (75:25)	**Linearity (r) :**	1.000
Flow Rate:	1.2 mL/min		
Wavelength:	215 nm		

		Verified Concentration (µg/mL)	**%RSD - Homogeneity**
Standard Solution	**Lot Number**	**Actual Results**	**Actual Results**
New Lot	FN06142422	99.7	0.2
Previous Lot	FN07272116	100.2	0.2

- Concentration is verified through multiple analyses and is calculated as the average of multiple analyses compared to an independently prepared calibration solution.
- Within-sample and between-sample homogeneity of the New Lot is ensured through rigorous production process controls statistically analyzed to evaluate risk and verified by analysis. Multiple samples pulled from across the lot using a random stratified sampling plan were analyzed to verify homogeneity. % RSD results shown above for the New Lot demonstrate ampoule-to-ampoule homogeneity.

Analyte Certification - Purity Factor

Each analyte is thoroughly identified and characterized using an orthogonal approach. A purity factor is assigned incorporating chromatographic purity and residual impurities. The purity factor is utilized to calculate the weighing adjustment necessary to ensure accuracy of the solution standard concentration.

Material Name:	(-)-11-nor-9-Carboxy-Δ^9-THC	**Chemical Formula:**	$C_{21}H_{28}O_4$
Material Lot:	FN09132104	**CAS Number:**	56354-06-4
		Molecular Weight:	344.44

Material Characterization Summary

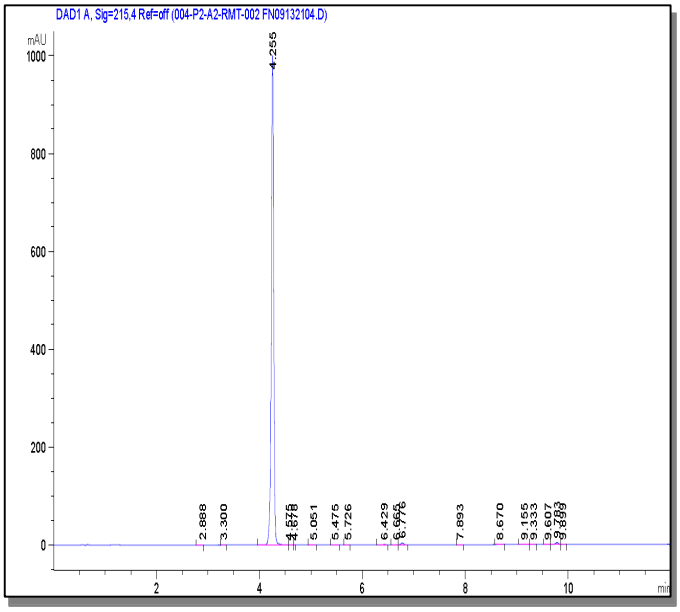
Analytical Test	**Method**	**Results**		
Chromatographic Purity by HPLC/UV Analysis	20384348	98.9%		
Chiral Purity by HPLC/UV Analysis	20397796	< 1% (+)-trans-THC acid		
Identity by LC/MS Analysis	20384217	Consistent with Structure		
Isobaric Impurities by LC/MS Analysis	20384217	None Detected		
Identity by ^{1}H-NMR Analysis	20384224	Consistent with Structure		
Residual Solvent Analysis by GC/FID Headspace	20397799 [1]	Below Quantitation Limit		
Residual Water Analysis by Karl Fischer Coulometry	20384212 [1]	Below Quantitation Limit		
Elemental Analysis	20423678		Calculated	Analyzed
		C	73.23%	73.23%
		H	8.19%	8.39%
Inorganic Content by Microash Analysis	20384350	Below Quantitation Limit		
Mass Balance Purity Factor		98.89%		

[1] Validated analytical method

- The chromatographic purity is calculated as the average of two independently performed analyses utilizing two different methods. Acceptance criteria requires the purity values to be within 0.5% of each other.
- The purity method was selected to optimize resolution of impurities while minimizing degradation of the analyte.
- The chromatographic purity value is used to calculate the Mass Balance Purity Factor.
- Mass Balance Purity Factor = [(100 - wt% residual solvent - wt% residual water - wt% residual inorganics) x Chromatographic Purity/100].
- Mass Balance Purity Factor does not include adjustment for chiral and/or isotopic purity.

Spectral and Physical Data

HPLC/UV



Column: Ascentis Express C18, 2.7 µm, 3.0 x 100 mm

Mobile Phase: A: Acetonitrile
B: 0.1% Phosphoric acid in Water

Gradient:

Time (min)	% A	% B
0.0	55	45
8.0	90	10
10.0	90	10
10.1	55	45

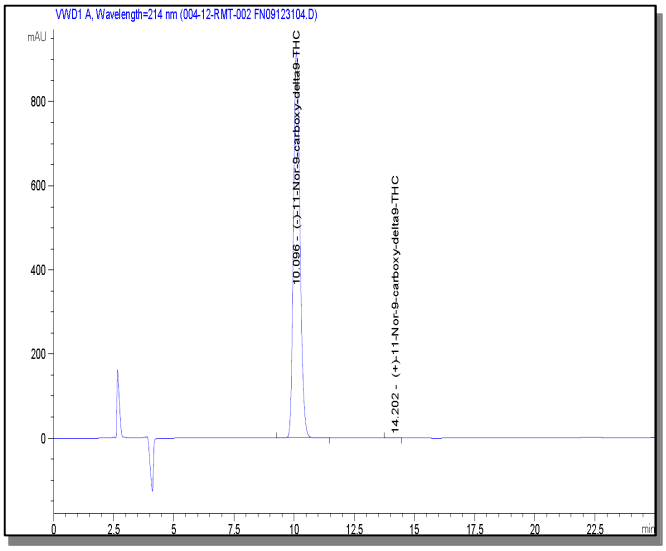
Flow Rate: 0.6 mL/min
Wavelength: 215 nm

Sample Name: FN09132104
Acquired: September 12, 2022

Peak #	Ret Time	Area %
1	2.89	0.01
2	3.30	0.01
3	4.26	98.89
4	4.58	0.02
5	4.68	0.00
6	5.05	0.02
7	5.48	0.01
8	5.73	0.01
9	6.43	0.06
10	6.67	0.02
11	6.78	0.38
12	7.89	0.01
13	8.67	0.02
14	9.16	0.05
15	9.33	0.01
16	9.61	0.05
17	9.78	0.41
18	9.90	0.03

Spectral and Physical Data (cont.)

Chiral Purity by HPLC/UV

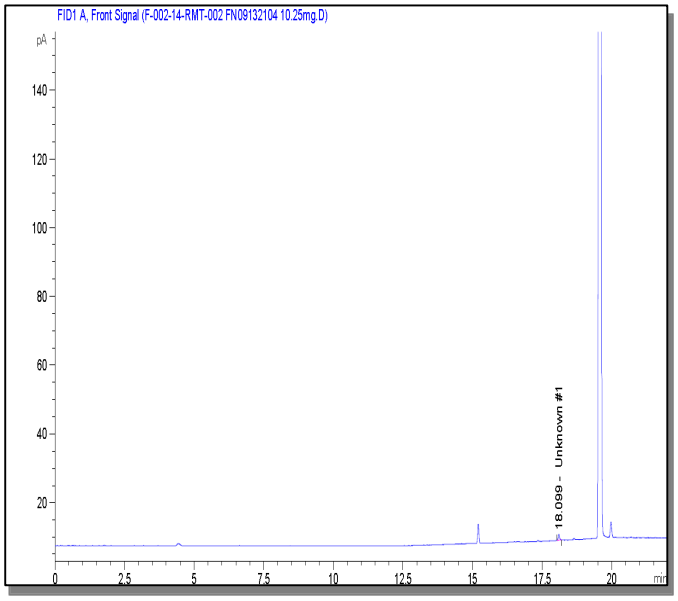


Column: Astec Cellulose DMP, 5 µm, 4.6 x 250 mm
Mobile Phase: Hexane:Ethanol:Trifluoroacetic acid (95:5:0.1)
Flow Rate: 1.2 mL/min
Wavelength: 214 nm

Sample Name: FN09132104
Acquired: September 13, 2022

Peak #	Ret Time	Area %	
1	10.10	99.99	(-)-THC acid
2	14.20	0.01	(+)-THC acid

Residual Solvent Analysis by GC/FID Headspace



Column: DB-ALC1 30 m x 0.53 mm, 3 µm film thickness
Temp Program: 40°C hold 12 min to 220°C at 40°C/min hold 5.5 min
Carrier Gas: Helium
Flow Rate: 2.0 mL/min
Detector Heater Temp: 250°C
Injector: Headspace Sampler
HS Oven Temp: 60°C
Vial Equilibration: 10 minutes

Sample Name: FN09132104
Acquired: September 08, 2022

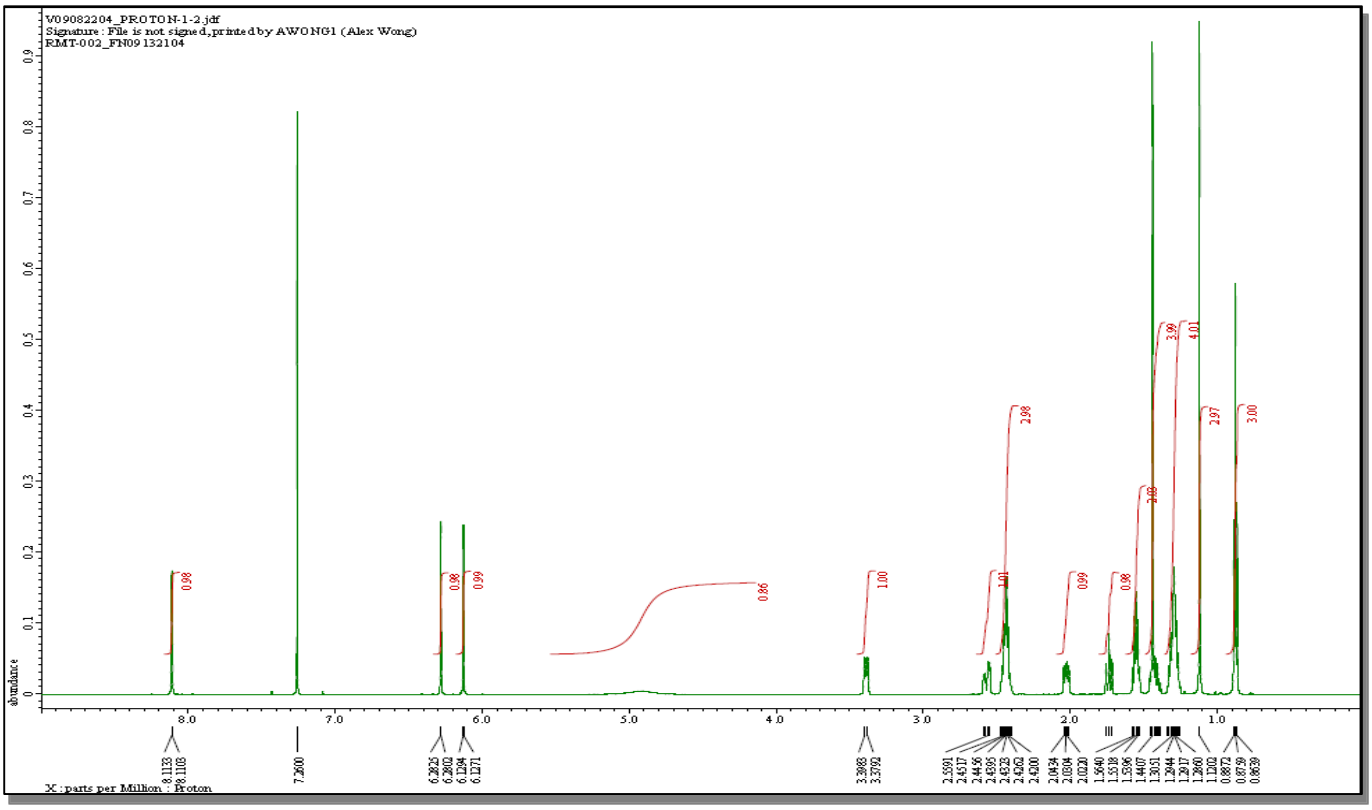
Peak	Compound	Area	Weight %
1	Unknown #1	5.72	BQL
2	NMP	NA	NA
Total			**BQL**

BQL - Below Quantitation Limit

Spectral and Physical Data (cont.)

^{1}H NMR

Instrument: JEOL ECZ600R
Solvent: Chloroform-D



Spectral and Physical Data (cont.)

LC/MS

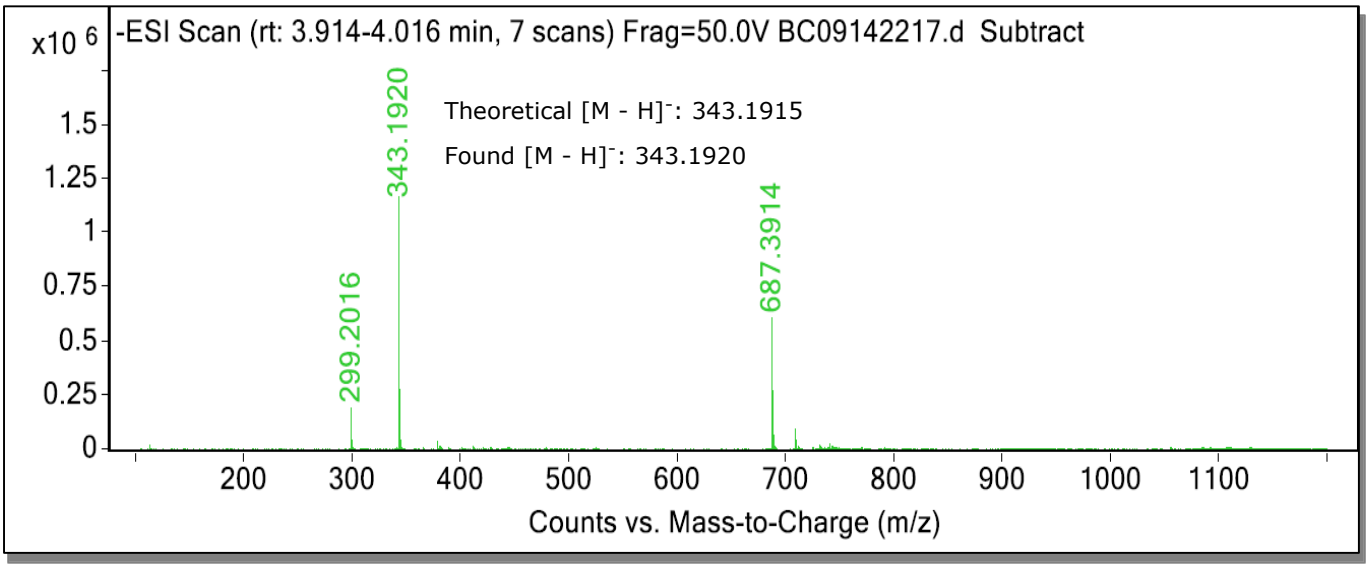
Column: Ascentis Express C18, 2.7 µm, 3.0 x 50 mm

Mobile Phase: A: 0.1% Formic acid in Water
B: Acetonitrile

Gradient:

Time (min)	% A	% B
0.0	50	50
0.5	50	50
4.0	10	90
5.8	10	90
6.0	50	50
8.0	50	50

Flow Rate: 0.4 mL/min
Scan Range: 100-1200 amu
Ionization: Electrospray, Negative Ion
Instrument: Agilent 6545XT QTOF
Acquired: September 14, 2022



Stability

Short term stability studies have been performed in multiple storage conditions for a period of up to four weeks. Short term data is utilized to support transport conditions and normal laboratory use. Real-time stability studies are performed at the recommended storage conditions over the life of the product.

Short Term Stability: *A summary of stability findings for a related product (T-006, (±)-11-nor-9-Carboxy-delta-9- THC) is listed below.*

Storage Condition	Targeted Mean Kinetic Temperature (MKT)	Time Period/Result
Freezer	-15°C	No decrease in purity was noted after four weeks.
Refrigerator	4°C	
Room Temperature	21°C	
40°C	40°C	

Transport/Shipping: *Stability studies support the transport of this product at ambient conditions.*

Long Term Stability: *Long term stability has been assessed for Freezer storage (-10 °C to -25 °C) conditions. Stability of a minimum of 60 months has been established through real-time stability studies.*

Commutability

This standard is a solution of a pure substance in an organic solvent and is a Primary Standard. This Primary Standard is suitable for use in the preparation of calibrators and/or controls in any biological matrix. This standard is not in a biological matrix and therefore commutability to methods or standards in biological matrices does not apply.

COA Revision History

Revision No.	Date	Reason for Revision
00	August 05, 2025	Initial version.

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