

Levetiracetam Extended-Release Tablets

Type of Posting	Revision Bulletin
Posting Date	26–May–2017
Official Date	01–Jun–2017
Expert Committee	Chemical Medicines Monographs 4
Reason for Revision	Compliance

In accordance with the Rules and Procedures of the 2015-2020 Council of Experts, the Chemical Medicines Monographs 4 Expert Committee has revised the Levetiracetam Extended-Release Tablets monograph.

The purpose for the revision is to add *Dissolution Test 8* for drug products approved by the FDA with different conditions and tolerances than the existing dissolution tests. This test was validated using a Kromasil C18 brand of 4.6-mm x 15-cm, 5- μ m packing L1 column manufactured by Akzo Nobel. Additionally, minor editorial changes have been made to update the monograph to current *USP* style.

The Levetiracetam Extended-Release Tablets Revision Bulletin supersedes the currently official Levetiracetam Extended-Release Tablets monograph. The Revision Bulletin will be incorporated in the *USP 41–NF 36*.

Should you have any questions, please contact Ren-Hwa Yeh, Ph.D., Senior Scientific Liaison, (301–998–6818 or rhy@usp.org).

Levetiracetam Extended-Release Tablets

DEFINITION

Levetiracetam Extended-Release Tablets contain NLT 90.0% and NMT 110.0% of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$).

IDENTIFICATION

- **A.** The retention time of the major peak of the *Sample solution* corresponds to that of the *Standard solution*, as obtained in the *Assay*.

ASSAY

• PROCEDURE

Buffer: 1.4 g/L of anhydrous dibasic sodium phosphate in water. Adjust with phosphoric acid to a pH of 3.5.

Mobile phase: Acetonitrile and *Buffer* (10:90)

Standard stock solution: 1.0 mg/mL of USP Levetiracetam RS prepared as follows. Weigh a suitable quantity of the Reference Standard into a volumetric flask. Add *Mobile phase* to fill 60% of flask volume and tetrahydrofuran to fill 4% of flask volume. Sonicate in cool water to dissolve. Equilibrate to room temperature. Dilute with *Mobile phase* to volume.

Standard solution: 0.08 mg/mL of USP Levetiracetam RS in *Mobile phase* from *Standard stock solution*. Pass a portion of the solution through a suitable filter of 0.45- μ m pore size.

Sample stock solution: Nominally ($L/100$) mg/mL of levetiracetam from NLT 5 Tablets prepared as follows, where L is the label claim in mg/Tablet. Transfer the Tablets to a volumetric flask containing tetrahydrofuran to fill about 5% of flask volume. Stir for 30 min, and allow to stand for 5 min. Sonicate for 20 min with intermittent shaking. Add *Mobile phase* to fill 80% of final volume, and sonicate in cold water for 20 min with intermittent shaking. Add methanol to fill 10% of flask volume. Dilute with *Mobile phase* to volume. Centrifuge for 15 min, and pass a portion of the solution through a suitable filter of 0.2- μ m pore size.

Alternatively, the *Sample stock solution*, having a nominal concentration of 3 mg/mL of levetiracetam, may be prepared as follows. Finely grind NLT 10 Tablets, and transfer an amount equivalent to 750 mg of levetiracetam to a suitable volumetric flask. Add 18% of the flask volume of acetonitrile. Sonicate for 10 min followed by shaking using a mechanical shaker for 10 min. Add 18% of the flask volume of water, and shake for 15 min using a mechanical shaker. Allow the sample to equilibrate to room temperature, and dilute with a mixture of acetonitrile and water (50:50) to volume. Pass a portion of the solution through a suitable filter of 0.45- μ m pore size.

Sample solution: Nominally 0.08 mg/mL of levetiracetam in *Mobile phase* from *Sample stock solution*

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 205 nm

Column: 4.6-mm \times 25-cm; 5- μ m packing L7

Temperatures

Column: 30°

Autosampler: 10°

Flow rate: 1.5 mL/min

Injection volume: 10 μ L

Run time: 3 times the retention time of levetiracetam

System suitability

Sample: *Standard solution*

Suitability requirements

Tailing factor: NMT 2.0

Relative standard deviation: NMT 2.0%

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) in the portion of Tablets taken:

$$\text{Result} = (r_U/r_S) \times (C_S/C_U) \times 100$$

r_U = peak response of levetiracetam from the *Sample solution*

r_S = peak response of levetiracetam from the *Standard solution*

C_S = concentration of USP Levetiracetam RS in the *Standard solution* (mg/mL)

C_U = nominal concentration of levetiracetam in the *Sample solution* (mg/mL)

Acceptance criteria: 90.0%–110.0%

PERFORMANCE TESTS

Change to read:

• DISSOLUTION <711>

Test 1

Buffer A: Dissolve 6.8 g of potassium dihydrogen phosphate and 0.2 g of sodium hydroxide in 1 L of water. If necessary, adjust with 1 N sodium hydroxide to a pH of 6.0.

Medium: *Buffer A*; 900 mL

Apparatus 1: 100 rpm

Times: 1, 2, 4, and 8 h

Buffer B: 1.4 g/L of anhydrous dibasic sodium phosphate in water. Adjust with phosphoric acid to a pH of 3.5.

Mobile phase: Acetonitrile and *Buffer B* (10:90)

Standard stock solution: 1.7 mg/mL of USP Levetiracetam RS in water. Sonication may be used to aid in dissolution.

Standard solution: ($L/900$) mg/mL of USP Levetiracetam RS in *Medium* from *Standard stock solution*, where L is the label claim in mg/Tablet. Pass a portion through a suitable filter of 0.45- μ m pore size.

Sample solution: Pass a portion of the solution under test through a suitable filter of 0.45- μ m pore size.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 205 nm

Column: 4.6-mm \times 25-cm; 5- μ m packing L7

Temperatures

Column: 30°

Autosampler: 10°

Flow rate: 1.5 mL/min

Injection volume: 5 μ L

Run time: 2 times the retention time of levetiracetam

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System suitability

Sample: *Standard solution*

Suitability requirements

Tailing factor: NMT 2.0

Relative standard deviation: NMT 2.0%

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in *Medium* (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times C_S$$

r_U = peak response from the *Sample solution*

r_S = peak response from the *Standard solution*

C_S = concentration of the *Standard solution* (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = [(C_2 \times V) + (C_1 \times V_S)] \times (1/L) \times 100$$

$$\text{Result}_3 = \{(C_3 \times V) + [(C_2 + C_1) \times V_S]\} \times (1/L) \times 100$$

$$\text{Result}_4 = \{(C_4 \times V) + [(C_3 + C_2 + C_1) \times V_S]\} \times (1/L) \times 100$$

C_i = concentration of levetiracetam in the portion of sample withdrawn at the specified time point (mg/mL)

V = volume of *Medium*, 900 mL

L = label claim (mg/Tablet)

V_S = volume of the *Sample solution* withdrawn at each time point and replaced with *Medium* (mL)

Tolerances: See *Table 1*.

Table 1

Time Point (j)	Time (h)	Amount Dissolved	
		500 mg/ Tablet (%)	750 mg/ Tablet (%)
1	1	25–45	33–53
2	2	45–65	45–65
3	4	60–80	65–85
4	8	NLT 80	NLT 80

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* <711>, *Acceptance Table 2*.

Test 2: If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 2*.

Buffer A: Dissolve 6.8 g of potassium dihydrogen phosphate and 0.2 g of sodium hydroxide in 1 L of water. If necessary, adjust with 1 N sodium hydroxide to a pH of 6.0.

Medium: *Buffer A*; 900 mL

Apparatus 1: 100 rpm

Times: 1, 2, 4, and 8 h

Buffer B: 2.82 g/L of potassium dihydrogen phosphate in water

Mobile phase: Acetonitrile and *Buffer B* (5:95). Adjust with phosphoric acid to a pH of 2.0.

Standard solution: ($L/900$) mg/mL of USP Levetiracetam RS in *Medium*, where L is the label claim in mg/Tablet

Sample solution: Pass a portion of the solution under test through a suitable filter of 0.45- μ m pore size.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 235 nm

Columns

Guard: 4.6-mm \times 1-cm, 4.6-mm \times 2-cm, or 4.0-mm \times 2-cm; 5- μ m packing L1

Analytical: 4.6-mm \times 5-cm; 5- μ m packing L1

Flow rate: 0.8 mL/min

Injection volume: 10 μ L

Run time: 2 times the retention time of levetiracetam

System suitability

Sample: *Standard solution*

Suitability requirements

Tailing factor: NMT 2.0

Relative standard deviation: NMT 1.5% for five replicate injections

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in *Medium* (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times C_S$$

r_U = peak response from the *Sample solution*

r_S = peak response from the *Standard solution*

C_S = concentration of the *Standard solution* (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = \{[C_2 \times (V - V_S)] + (C_1 \times V_S)\} \times (1/L) \times 100$$

$$\text{Result}_3 = \{(C_3 \times [V - (2 \times V_S)]) + [(C_2 + C_1) \times V_S]\} \times (1/L) \times 100$$

$$\text{Result}_4 = \{(C_4 \times [V - (3 \times V_S)]) + [(C_3 + C_2 + C_1) \times V_S]\} \times (1/L) \times 100$$

C_i = concentration of levetiracetam in *Medium* in the portion of sample withdrawn at time point i (mg/mL)

V = volume of *Medium*, 900 mL

L = label claim (mg/Tablet)

V_S = volume of the *Sample solution* withdrawn from the *Medium* (mL)

Tolerances: See *Table 2*.

Table 2

Time Point (j)	Time (h)	Amount Dissolved	
		500 mg/ Tablet (%)	750 mg/ Tablet (%)
1	1	22–42	16–36
2	2	39–59	30–50
3	4	62–82	50–70
4	8	NLT 80	NLT 80

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* (711), *Acceptance Table 2*.

Test 3: If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 3*.

Buffer A: Dissolve 6.8 g of potassium dihydrogen phosphate (RB 1-Oct-2016) and 0.5 g of sodium hydroxide in 1 L of water. Adjust to a pH of 6.0.

Medium: Buffer A; 900 mL

Apparatus 1: 100 rpm

Times: 1, 2, 4, and 8 h

Buffer B: 7.8 g/L of monobasic sodium phosphate dihydrate (RB 1-Oct-2016) in water. Adjust with sodium hydroxide to a pH of 5.6.

Mobile phase: Acetonitrile and Buffer B (15:85)

Standard solution: ($L/900$) mg/mL of USP Levetiracetam RS in Medium, where L is the label claim in mg/Tablet

Sample solution: Centrifuge a portion of the solution under test.

Chromatographic system

(See *Chromatography* (621), *System Suitability*.)

Mode: LC

Detector: UV 220 nm

Column: 4.6-mm \times 15-cm; 5- μ m packing L1

Column temperature: 30°

Flow rate: 1.5 mL/min

Injection volume: 10 μ L

Run time: 2 times the retention time of levetiracetam

System suitability

Sample: Standard solution

Suitability requirements

Column efficiency: NLT 1500 theoretical plates

Relative standard deviation: NMT 2.0% for six replicate injections

Analysis

Samples: Standard solution and Sample solution

Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in Medium (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times C_S$$

r_U = peak response from the Sample solution

r_S = peak response from the Standard solution

C_S = concentration of USP Levetiracetam RS in the Standard solution (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = \{[C_2 \times (V - V_3)] + (C_1 \times V_3)\} \times (1/L) \times 100$$

$$\text{Result}_3 = \{(C_3 \times [V - (2 \times V_3)]) + [(C_2 + C_1) \times V_3]\} \times (1/L) \times 100$$

$$\text{Result}_4 = \{(C_4 \times [V - (3 \times V_3)]) + [(C_3 + C_2 + C_1) \times V_3]\} \times (1/L) \times 100$$

C_i = concentration of levetiracetam in Medium in the portion of sample withdrawn at time point i (mg/mL)

V = volume of Medium, 900 mL

L = label claim (mg/Tablet)

V_3 = volume of the Sample solution withdrawn from the Medium (mL)

Tolerances: See Table 3.

Table 3

Time Point (i)	Time (h)	Amount Dissolved		
		500 mg/ Tablet (%)	750 mg/ Tablet (%)	1000 mg/ Tablet (%) (RB 1-Oct-2016)
1	1	42–62	35–55	35–55 (RB 1-Oct-2016)
2	2	59–79	50–70	50–70 (RB 1-Oct-2016)
3	4	78–98	70–90	70–90 (RB 1-Oct-2016)
4	8	NLT 80	NLT 80	NLT 80 (RB 1-Oct-2016)

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* (711), *Acceptance Table 2*.

Test 4: If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 4*.

Buffer: 6.8 g/L of monobasic potassium phosphate in water. Adjust with sodium hydroxide to a pH of 6.0.

Medium: Buffer; 900 mL

Apparatus 1: 100 rpm

Times: 1, 2, 4, and 8 h

Standard solution: ($L/900$) mg/mL of USP Levetiracetam RS in Medium, where L is the label claim in mg/Tablet

Sample solution: Pass a suitable portion of the solution under test through a suitable filter of 0.45- μ m pore size. Discard the first 3 mL of the filtrate. Dilute a known volume of the remaining filtrate quantitatively with Medium.

Blank: Medium

Instrumental conditions

Mode: UV

Analytical wavelength: 210 nm

Analysis

Samples: Standard solution and Sample solution

Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in Medium (mg/mL) after time point i :

$$\text{Result}_i = (A_U/A_S) \times C_S$$

A_U = absorbance of the Sample solution

A_S = absorbance of the Standard solution

C_S = concentration of the Standard solution (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = [(C_2 \times V) + (C_1 \times V_3)] \times (1/L) \times 100$$

$$\text{Result}_3 = \{(C_3 \times V) + [(C_2 + C_1) \times V_3]\} \times (1/L) \times 100$$

$$\text{Result}_4 = \{(C_4 \times V) + [(C_3 + C_2 + C_1) \times V_3]\} \times (1/L) \times 100$$

C_i = concentration of levetiracetam in the portion of sample withdrawn at the specified time point (mg/mL)

V = volume of Medium, 900 mL

L = label claim (mg/Tablet)

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V_s = volume of the *Sample solution* withdrawn at each time point and replaced with *Medium* (mL)

Tolerances: See *Table 4*.

Table 4

Time Point (j)	Time (h)	Amount Dissolved	
		500 mg/ Tablet (%)	750 mg/ Tablet (%)
1	1	22–42	16–36
2	2	39–59	30–50
3	4	62–82	50–70
4	8	NLT 80	NLT 80

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* <711>, *Acceptance Table 2*.

Test 5: If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 5*.

Medium: pH 6.0 phosphate buffer (6.8 g/L of monobasic potassium phosphate in water. Adjust with sodium hydroxide to a pH of 6.0.); 900 mL

Apparatus 1: 100 rpm

Times: 1, 4, 8, and 12 h

Buffer: 2.7 g/L of monobasic potassium phosphate in water

Mobile phase: Acetonitrile and *Buffer* (10:90)

Standard stock solution: 2.8 mg/mL of USP Levetiracetam RS in *Medium* prepared as follows. Transfer a suitable quantity of USP Levetiracetam RS to a suitable volumetric flask. Dissolve in 20% of the flask volume of methanol. Dilute with *Medium* to volume.

Standard solution: ($L/900$) mg/mL of USP Levetiracetam RS in *Medium* from *Standard stock solution*, where L is the label claim in mg/Tablet

Sample solution: At each time point withdraw 1 mL of the solution under test, and pass it through a suitable filter of 0.45- μ m pore size.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 220 nm

Column: 4.6-mm \times 15-cm; 5- μ m packing L11

Flow rate: 1 mL/min

Injection volume: 10 μ L

Run time: 2 times the retention time of levetiracetam

System suitability

Sample: *Standard solution*

Suitability requirements

Column efficiency: NLT 4000 theoretical plates

Tailing factor: NMT 1.5

Relative standard deviation: NMT 2.0% for five replicate injections

Analysis

Samples: *Standard solution* and *Sample solution*
Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved in *Medium* (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times C_S \times V \times (1/L) \times 100$$

r_U = peak response from the *Sample solution*

r_S = peak response from the *Standard solution*

C_S = concentration of USP Levetiracetam RS in the *Standard solution* (mg/mL)

V = volume of *Medium*, 900 mL

L = label claim (mg/Tablet)

Tolerances: See *Table 5*.

Table 5

Time Point (j)	Time (h)	Amount Dissolved (%)
1	1	NMT 40
2	4	55–80
3	8	NLT 75
4	12	NLT 85

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* <711>, *Acceptance Table 2*.

Test 6: If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 6*.

Medium: pH 6.0 phosphate buffer (6.9 g of monobasic sodium phosphate, and 0.23 g of sodium hydroxide in 1 L of water. Adjust with sodium hydroxide or phosphoric acid to a pH of 6.0.); 900 mL

Apparatus 1: 100 rpm

Times: 1, 2, 4, and 8 h

Mobile phase: Acetonitrile and water (10:90)

Standard solution: 0.5 mg/mL of USP Levetiracetam RS in *Medium* prepared as follows. Transfer a suitable quantity of USP Levetiracetam RS to a suitable volumetric flask. Add 4% of the flask volume of methanol and 60% of the flask volume of the *Medium*. Sonicate for NLT 5 min. Dilute with *Medium* to volume.

Sample solution: At the end of specified time interval, withdraw a known volume of the solution from the dissolution vessel. Pass a suitable portion of the solution under test through a suitable filter of 0.45- μ m pore size.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 230 nm

Column: 4.6-mm \times 5-cm; 5- μ m packing L1

Column temperature: 30°

Flow rate: 0.9 mL/min

Injection volume: 10 μ L

Run time: 2 times the retention time of levetiracetam

System suitability

Sample: *Standard solution*

Suitability requirements

Tailing factor: NMT 2.0

Relative standard deviation: NMT 2.0%

Analysis

Samples: *Standard solution* and *Sample solution*
Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in *Medium* (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times C_S$$

r_U = peak response from the *Sample solution*

r_S = peak response from the *Standard solution*

C_S = concentration of the *Standard solution* (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = \{[C_2 \times (V - V_3)] + (C_1 \times V_3)\} \times (1/L) \times 100$$

$$\text{Result}_3 = \{[C_3 \times [V - (2 \times V_3)]] + [(C_2 + C_1) \times V_3]\} \times (1/L) \times 100$$

$$\text{Result}_4 = \{[C_4 \times [V - (3 \times V_3)]] + [(C_3 + C_2 + C_1) \times V_3]\} \times (1/L) \times 100$$

C_i = concentration of levetiracetam in *Medium* in the portion of sample withdrawn at time point i (mg/mL)

V = volume of *Medium*, 900 mL

L = label claim (mg/Tablet)

V_3 = volume of the *Sample solution* withdrawn from the solution under test (mL)

Tolerances: See *Table 6*.

Table 6

Time Point (i)	Time (h)	Amount Dissolved (%)
1	1	25–45
2	2	45–65
3	4	60–80
4	8	NLT 80

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* <711>, *Acceptance Table 2*.

• **Test 7:** If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 7*.

Medium: Acetate buffer, pH 4.5, prepared as follows. Dissolve 3.0 g of sodium acetate in 1 L of water and add 1.4 mL of glacial acetic acid. Adjust with 5 N sodium hydroxide or glacial acetic acid to a pH of 4.5; 230 mL.

Apparatus 3: 15 dips per min, with suitable screens

Times
 For 500-mg Tablets: 1, 2, 4, and 8 h

For 750-mg Tablets: 1, 2, 4, and 10 h

Buffer: 13.6 g/L of monobasic potassium phosphate in water. Adjust with 5 N sodium hydroxide to a pH of 6.0.

Mobile phase: Methanol and *Buffer* (15:85)

Standard solution: 0.55 mg/mL of USP Levetiracetam RS in *Medium*. (ERR 1-Feb-2017). Sonication may be used to aid in dissolution.

Sample solution: Pass a suitable portion of the solution under test through a suitable filter of 0.45- μ m pore size. Discard the first 5 mL. Dilute a suitable volume of the filtrate with *Medium*, as needed.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 210 nm

Column: 4.6-mm \times 10-cm; 3- μ m packing L1

Column temperature: 30°

Flow rate: 1 mL/min

Injection volume: 10 μ L

Run time: 2 times the retention time of levetiracetam

System suitability

Sample: *Standard solution*

Suitability requirements

Tailing factor: NMT 2.0

Relative standard deviation: NMT 2.0%

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in *Medium* (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times D \times C_S$$

r_U = peak response from the *Sample solution*

r_S = peak response from the *Standard solution*

D = dilution factor, as needed

C_S = concentration of the *Standard solution* (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = C_2 \times V \times (1/L) \times 100 + \text{Result}_1$$

$$\text{Result}_3 = C_3 \times V \times (1/L) \times 100 + \text{Result}_2$$

$$\text{Result}_4 = C_4 \times V \times (1/L) \times 100 + \text{Result}_3$$

C_i = concentration of levetiracetam in the portion of sample withdrawn at the specified time point (mg/mL)

V = volume of *Medium*, 230 mL

L = label claim (mg/Tablet)

Tolerances: See *Table 7*.

Table 7

Time Point (i)	Time (h)	Amount Dissolved	
		500 mg/ Tablet (%)	750 mg/ Tablet (%)
1	1	15–35	10–30
2	2	30–50	25–45
3	4	50–75	45–70
4	8	NLT 80	—
	10	—	NLT 80

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* <711>, *Acceptance Table 2*. (RB 1-Apr-2016)

• **Test 8:** If the product complies with this procedure, the labeling indicates that it meets USP *Dissolution Test 8*.

Medium: Phosphate buffer, pH 6.0, prepared as follows. Dissolve 6.8 g of monobasic potassium phosphate in 1 L of water. Adjust with 10 N sodium hydroxide solution to a pH of 6.0; 900 mL.

Apparatus 1: 100 rpm

Times: 1, 2, 4, and 12 h

Buffer: 0.26 g/L of monobasic potassium phosphate in water. Adjust with 20 g/L aqueous potassium hydroxide to a pH of 5.5.

Solution A: Acetonitrile and *Buffer* (5:95)

Mobile phase: Acetonitrile and *Solution A* (10:90)

Standard solution: ($L/900$) mg/mL of USP Levetiracetam RS in *Medium*, where L is the label claim in mg/Tablet. Sonicate to dissolve as needed.

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Sample solution: Pass a portion of the solution under test through a suitable filter of 0.45- μ m pore size.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 220 nm

Column: 4.6-mm \times 15-cm; 5- μ m packing L1

Column temperature: 20 $^{\circ}$

Flow rate: 1 mL/min

Injection volume: 5 μ L

Run time: NLT 1.6 times the retention time of levetiracetam

System suitability

Sample: *Standard solution*

Suitability requirements

Tailing factor: NMT 1.5

Relative standard deviation: NMT 1.8%

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the concentration, C_i , of levetiracetam ($C_8H_{14}N_2O_2$) in *Medium* (mg/mL) after time point i :

$$\text{Result}_i = (r_U/r_S) \times C_S$$

r_U = peak response from the *Sample solution*

r_S = peak response from the *Standard solution*

C_S = concentration of the *Standard solution* (mg/mL)

Calculate the percentage of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$) dissolved at each time point (i):

$$\text{Result}_1 = C_1 \times V \times (1/L) \times 100$$

$$\text{Result}_2 = \{[C_2 \times (V - V_S)] + (C_1 \times V_S)\} \times (1/L) \times 100$$

$$\text{Result}_3 = \{[C_3 \times [V - (2 \times V_S)]] + [(C_2 + C_1) \times V_S]\} \times (1/L) \times 100$$

$$\text{Result}_4 = \{[C_4 \times [V - (3 \times V_S)]] + [(C_3 + C_2 + C_1) \times V_S]\} \times (1/L) \times 100$$

C_i = concentration of levetiracetam in the portion of sample withdrawn at time point i (mg/mL)

V = volume of *Medium*, 900 mL

L = label claim (mg/Tablet)

V_S = volume of the *Sample solution* withdrawn from the *Medium* (mL)

Tolerances: See *Table 8*.

Table 8

Time Point (i)	Time (h)	Amount Dissolved (%)
1	1	25–45
2	2	40–60
3	4	55–75
4	12	NLT 80

The percentages of the labeled amount of levetiracetam ($C_8H_{14}N_2O_2$), dissolved at the times specified, conform to *Dissolution* <711>, *Acceptance Table 2*. • (RB 1-Jun-2017)

- **UNIFORMITY OF DOSAGE UNITS** <905>: Meet the requirements

IMPURITIES

• **ORGANIC IMPURITIES**

Solution A: Dilute 2 mL of phosphoric acid with water to 1 L.

Diluent: Acetonitrile and *Solution A* (5:95)

Buffer: 1.4 g/L of anhydrous dibasic sodium phosphate in water. Adjust with phosphoric acid to a pH of 3.5.

Mobile phase: Acetonitrile and *Buffer* (5:95). To each L of the mixture, add 1 g of sodium 1-hexanesulfonate monohydrate.

System suitability solution: 0.3 mg/mL of USP Levetiracetam RS in *Diluent* prepared as follows. Dissolve the required amount of USP Levetiracetam RS in 10% of the final volume of 0.1 N potassium hydroxide. Let the mixture react at room temperature for about 15 min, and then neutralize by adding 0.1 N hydrochloric acid at 10% of the flask volume. Dilute with *Diluent* to volume. [NOTE—This solution contains levetiracetam and levetiracetam acid.]

Standard solution: 12.5 μ g/mL of USP Levetiracetam RS in water. Sonication may be used to aid in dissolution. Pass a portion of the solution through a suitable filter of 0.2- μ m pore size.

Sample solution: Nominally equivalent to 2.5 mg/mL of levetiracetam in water, from a portion of crushed Tablets (NLT 20) prepared as follows. Transfer the weighed amount of crushed Tablet powder to a volumetric flask containing water to fill 80% of final volume. Sonicate in cold water for 10 min. Equilibrate to room temperature. Dilute with water to volume. Pass a portion through a suitable filter of 0.2- μ m pore size. Alternatively, the *Sample solution* having a nominal concentration of 2–3 mg/mL of levetiracetam may be prepared as follows. Finely grind NLT 10 Tablets, and transfer an amount equivalent to one Tablet to a suitable volumetric flask. Add NLT 30 mL of acetonitrile. Sonicate for 10 min, and shake using a mechanical shaker for 10 min. Add NLT 30 mL of water, and shake for 15 min using a mechanical shaker. Allow the resulting mixture to equilibrate to room temperature. Add NMT 25% of the final flask volume of acetonitrile. Dilute with water to volume. Centrifuge for 15 min, and pass a portion through a suitable filter of 0.45- μ m pore size.

Chromatographic system

(See *Chromatography* <621>, *System Suitability*.)

Mode: LC

Detector: UV 205 nm

Column: 4.6-mm \times 25-cm; 5- μ m packing L1

Temperatures

Column: 30 $^{\circ}$

Autosampler: 10 $^{\circ}$

Flow rate: 2 mL/min

Injection volume: 20 μ L

Run time: 5 times the retention time of levetiracetam

System suitability

Samples: *System suitability solution* and *Standard solution*

Suitability requirements

Resolution: NLT 1.5 between levetiracetam and levetiracetam acid peaks, *System suitability solution*

Tailing factor: NMT 2.0, *Standard solution*

Relative standard deviation: NMT 5.0%, *Standard solution*

Analysis

Samples: *Standard solution* and *Sample solution*

Calculate the percentage of any unspecified degradation product in the portion of Tablets taken:

$$\text{Result} = (r_U/r_S) \times (C_S/C_U) \times 100$$

r_U = peak response of each impurity from the *Sample solution*
 r_S = peak response of USP Levetiracetam RS from the *Standard solution*
 C_S = concentration of USP Levetiracetam RS in the *Standard solution* (mg/mL)
 C_U = nominal concentration of levetiracetam in the *Sample solution* (mg/mL)

Acceptance criteria: See Table 9.

Table 9

Name	Relative Retention Time	Acceptance Criteria, NMT (%)
Levetiracetam related compound B ^{a,b}	0.40	—
Levetiracetam	1.0	—
Levetiracetam acid ^c	1.3	0.30
Levetiracetam related compound A ^{b,d}	1.9	—

^a (S)-2-Aminobutanamide.

^b Process impurities controlled in the drug substance. Included for identification purposes only. Not reported for the drug product, and not included in total impurities.

^c (S)-2-(2-Oxopyrrolidin-1-yl)butanoic acid.

^d (S)-N-(1-Amino-1-oxobutan-2-yl)-4-chlorobutanamide.

Table 9 (Continued)

Name	Relative Retention Time	Acceptance Criteria, NMT (%)
Any individual unspecified degradation product	—	0.10
Total impurities	—	1.0

^a (S)-2-Aminobutanamide.

^b Process impurities controlled in the drug substance. Included for identification purposes only. Not reported for the drug product, and not included in total impurities.

^c (S)-2-(2-Oxopyrrolidin-1-yl)butanoic acid.

^d (S)-N-(1-Amino-1-oxobutan-2-yl)-4-chlorobutanamide.

ADDITIONAL REQUIREMENTS

- **PACKAGING AND STORAGE:** Preserve in well-closed containers. Store at controlled room temperature.
- **LABELING:** When more than one *Dissolution* test is given, the labeling states the *Dissolution* test used only if *Test 1* is not used.
- **USP REFERENCE STANDARDS <11>**
 USP Levetiracetam RS