



Full wwPDB X-ray Structure Validation Report ⓘ

Sep 18, 2025 – 01:09 pm BST

PDB ID : 9RCI / pdb_00009rci
Title : Crystal Structure of Flap Endonuclease FEN1 with Compound 28
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Deposited on : 2025-05-29
Resolution : 1.66 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4-5-2 with Phenix2.0rc1
Mogul : 1.8.4, CSD as541be (2020)
Xtriage (Phenix) : 2.0rc1
EDS : 3.0
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4 : 9.0.006 (Gargrove)
Density-Fitness : 1.0.12
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.45.1

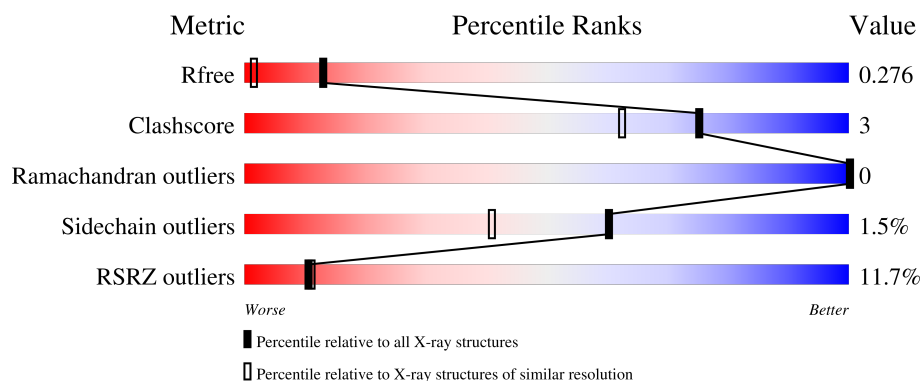
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.66 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	2328 (1.66-1.66)
Clashscore	180529	2515 (1.66-1.66)
Ramachandran outliers	177936	2475 (1.66-1.66)
Sidechain outliers	177891	2475 (1.66-1.66)
RSRZ outliers	164620	2328 (1.66-1.66)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	342	 9% 73% 6% 21%
1	B	342	 10% 71% 7% 22%

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 4551 atoms, of which 46 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called Flap endonuclease 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	270	Total	C	N	O	S	0	3	0
			2127	1358	355	397	17			
1	B	268	Total	C	N	O	S	0	3	0
			2121	1353	354	397	17			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	337	LEU	-	expression tag	UNP P39748
A	338	GLU	-	expression tag	UNP P39748
A	339	VAL	-	expression tag	UNP P39748
A	340	LEU	-	expression tag	UNP P39748
A	341	PHE	-	expression tag	UNP P39748
A	342	GLN	-	expression tag	UNP P39748
B	337	LEU	-	expression tag	UNP P39748
B	338	GLU	-	expression tag	UNP P39748
B	339	VAL	-	expression tag	UNP P39748
B	340	LEU	-	expression tag	UNP P39748
B	341	PHE	-	expression tag	UNP P39748
B	342	GLN	-	expression tag	UNP P39748

- Molecule 2 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

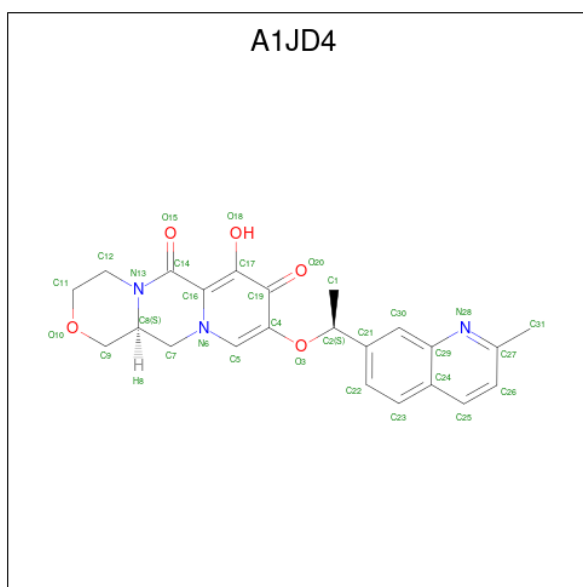
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	2	Total	Mg	0	0
			2	2		
2	B	2	Total	Mg	0	0
			2	2		

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: C₂H₆O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			4	2	2		
3	B	1	Total	C	O	0	0
			4	2	2		

- Molecule 4 is (3 {S})-13-[(1 {S})-1-(2-methylquinolin-7-yl)ethoxy]-11-oxidanyl-5-oxa-1,8-diazatricyclo[8.4.0.0[^]{3,8}]tetradeca-10,13-diene-9,12-dione (CCD ID: A1JD4) (formula: C₂₃H₂₃N₃O₅).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	H	N	O	23	0
			54	23	23	3	5		

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	B	1	Total	C	H	N	O	23	0
			54	23	23	3	5		

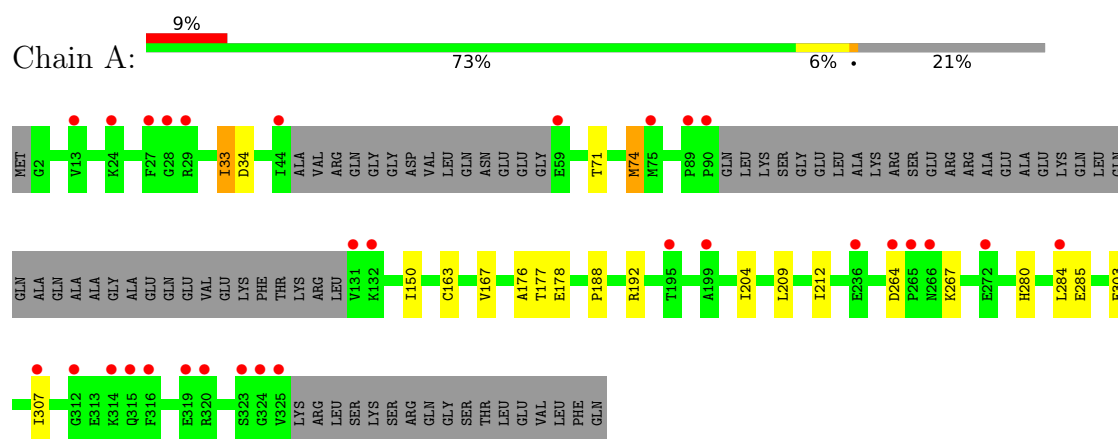
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	94	Total	O	0	0
			94	94		
5	B	89	Total	O	0	0
			89	89		

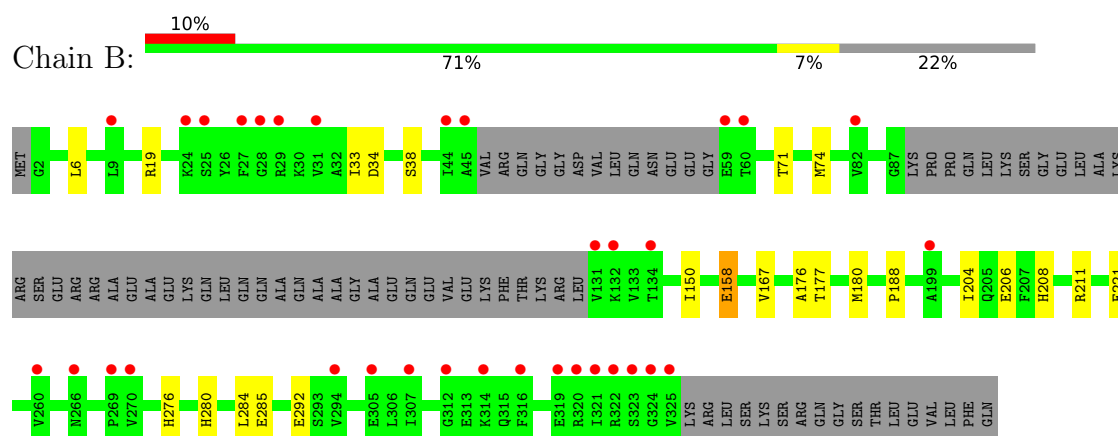
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

• Molecule 1: Flap endonuclease 1



• Molecule 1: Flap endonuclease 1



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	35.87Å 39.30Å 100.92Å 98.30° 90.32° 90.09°	Depositor
Resolution (Å)	33.08 – 1.66 33.08 – 1.66	Depositor EDS
% Data completeness (in resolution range)	69.8 (33.08-1.66) 69.8 (33.08-1.66)	Depositor EDS
R_{merge}	0.17	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.10 (at 1.66Å)	Xtriage
Refinement program	BUSTER 2.11.8 (10-JUL-2024)	Depositor
R, R_{free}	0.244 , 0.283 0.236 , 0.276	Depositor DCC
R_{free} test set	2159 reflections (3.36%)	wwPDB-VP
Wilson B-factor (Å ²)	15.6	Xtriage
Anisotropy	0.044	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.39 , 42.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	0.027 for h,-k,-l 0.074 for -h,k,-k-l 0.005 for -h,-k,k+l	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	4551	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.31% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: MG, A1JD4, EDO

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z > 5$	RMSZ	$\# Z > 5$
1	A	0.91	2/2169 (0.1%)	1.03	1/2930 (0.0%)
1	B	0.88	1/2161 (0.0%)	1.04	1/2915 (0.0%)
All	All	0.89	3/4330 (0.1%)	1.04	2/5845 (0.0%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	74	MET	SD-CE	-7.00	1.62	1.79
1	B	74	MET	SD-CE	-5.17	1.66	1.79
1	A	204	ILE	CG1-CD1	-5.17	1.31	1.51

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	163	CYS	N-CA-C	-5.33	105.55	111.36
1	B	221	GLU	CB-CG-CD	5.21	121.46	112.60

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2127	0	2111	12	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	2121	0	2115	13	0
2	A	2	0	0	0	0
2	B	2	0	0	0	0
3	A	4	0	6	0	0
3	B	4	0	6	1	0
4	A	31	23	0	0	0
4	B	31	23	0	0	0
5	A	94	0	0	0	0
5	B	89	0	0	1	0
All	All	4505	46	4238	25	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 3.

All (25) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:158:GLU:HG3	3:B:403:EDO:H11	1.66	0.75
1:A:264:ASP:HB3	1:A:267:LYS:HB2	1.86	0.57
1:A:209:LEU:HA	1:A:212:ILE:HD12	1.92	0.52
1:B:167:VAL:CG1	1:B:188:PRO:HD2	2.40	0.52
1:A:280:HIS:CD2	1:A:284:LEU:HD12	2.45	0.51
1:B:276:HIS:HD2	5:B:523:HOH:O	1.93	0.51
1:A:178:GLU:HA	1:A:192:ARG:HD2	1.94	0.50
1:B:6:LEU:HD23	1:B:180:MET:HB3	1.93	0.49
1:A:167:VAL:CG1	1:A:188:PRO:HD2	2.43	0.48
1:A:303:GLU:O	1:A:307:ILE:HG12	2.13	0.47
1:B:71:THR:HG21	1:B:150:ILE:HG13	1.96	0.47
1:B:34:ASP:CB	1:B:177:THR:HB	2.45	0.47
1:B:167:VAL:HG12	1:B:188:PRO:HD2	1.97	0.46
1:A:167:VAL:HG12	1:A:188:PRO:HD2	1.97	0.46
1:B:280:HIS:CD2	1:B:284:LEU:HD12	2.50	0.46
1:A:34:ASP:HB2	1:A:177:THR:HB	1.98	0.45
1:A:71:THR:HG21	1:A:150:ILE:HG13	1.98	0.45
1:B:34:ASP:HB2	1:B:177:THR:HB	1.98	0.45
1:A:280:HIS:NE2	1:A:284:LEU:CD1	2.81	0.44
1:B:33:ILE:HD13	1:B:176:ALA:HB3	2.00	0.43
1:A:71:THR:HA	1:A:74:MET:CE	2.49	0.43
1:A:33:ILE:HD13	1:A:176:ALA:HB3	2.01	0.42
1:B:280:HIS:NE2	1:B:284:LEU:HD12	2.35	0.41
1:B:19:ARG:HG3	1:B:206:GLU:HB3	2.03	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:208:HIS:ND1	1:B:211:ARG:NH1	2.69	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	267/342 (78%)	262 (98%)	5 (2%)	0	100	100
1	B	265/342 (78%)	260 (98%)	5 (2%)	0	100	100
All	All	532/684 (78%)	522 (98%)	10 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	231/294 (79%)	229 (99%)	2 (1%)	75	63
1	B	231/294 (79%)	226 (98%)	5 (2%)	47	24
All	All	462/588 (79%)	455 (98%)	7 (2%)	60	41

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	33	ILE
1	A	285	GLU
1	B	38	SER
1	B	158	GLU
1	B	204	ILE
1	B	285	GLU
1	B	292	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	138	ASN
1	B	138	ASN
1	B	276	HIS

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 8 ligands modelled in this entry, 4 are monoatomic - leaving 4 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
3	EDO	B	403	-	3,3,3	0.52	0	2,2,2	0.51	0
4	A1JD4	B	404	2	35,35,35	0.58	0	36,52,52	0.66	0
3	EDO	A	403	-	3,3,3	0.25	0	2,2,2	0.18	0
4	A1JD4	A	404	2	35,35,35	0.59	0	36,52,52	0.72	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	EDO	B	403	-	-	1/1/1/1	-
4	A1JD4	B	404	2	-	0/8/31/31	0/5/5/5
3	EDO	A	403	-	-	0/1/1/1	-
4	A1JD4	A	404	2	-	0/8/31/31	0/5/5/5

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	403	EDO	O1-C1-C2-O2

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	403	EDO	1	0

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2		OWAB(Å ²)	Q<0.9
1	A	270/342 (78%)	0.82	30 (11%)	12 12	6, 19, 35, 43	3 (1%)
1	B	268/342 (78%)	0.87	33 (12%)	9 10	6, 19, 37, 56	3 (1%)
All	All	538/684 (78%)	0.85	63 (11%)	10 11	6, 19, 36, 56	6 (1%)

All (63) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	325	VAL	6.7
1	B	324	GLY	6.6
1	B	45	ALA	4.5
1	B	323	SER	4.4
1	A	89	PRO	4.3
1	B	131	VAL	4.3
1	B	28	GLY	3.7
1	A	27	PHE	3.5
1	B	320	ARG	3.5
1	B	321	ILE	3.5
1	A	13	VAL	3.3
1	A	324	GLY	3.3
1	B	312	GLY	3.2
1	A	325	VAL	3.2
1	B	319	GLU	3.1
1	A	131	VAL	3.0
1	B	31[A]	VAL	3.0
1	A	272	GLU	2.9
1	B	322	ARG	2.9
1	B	59	GLU	2.9
1	A	323	SER	2.9
1	A	319	GLU	2.9
1	B	60	THR	2.9
1	A	314	LYS	2.8

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Mol	Chain	Res	Type	RSRZ
1	B	132	LYS	2.8
1	B	307	ILE	2.7
1	A	284	LEU	2.7
1	B	316	PHE	2.7
1	B	44	ILE	2.7
1	A	59	GLU	2.6
1	A	312	GLY	2.6
1	A	90	PRO	2.6
1	B	25	SER	2.5
1	B	24	LYS	2.5
1	B	305	GLU	2.5
1	B	27	PHE	2.4
1	A	199	ALA	2.4
1	A	266	ASN	2.4
1	A	132	LYS	2.4
1	A	236	GLU	2.4
1	A	265	PRO	2.3
1	A	44	ILE	2.3
1	A	75[A]	MET	2.3
1	B	260	VAL	2.3
1	B	266	ASN	2.2
1	A	320	ARG	2.2
1	B	82	VAL	2.2
1	B	270	VAL	2.2
1	A	28	GLY	2.2
1	B	29	ARG	2.2
1	A	315	GLN	2.2
1	A	29	ARG	2.1
1	B	9	LEU	2.1
1	B	294	VAL	2.1
1	B	199	ALA	2.1
1	A	195	THR	2.1
1	B	134	THR	2.1
1	A	307	ILE	2.1
1	A	316	PHE	2.1
1	A	264	ASP	2.0
1	A	24	LYS	2.0
1	B	314	LYS	2.0
1	B	269	PRO	2.0

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
4	A1JD4	B	404	31/31	0.92	0.10	10,14,22,23	23
4	A1JD4	A	404	31/31	0.93	0.08	11,15,20,21	23
3	EDO	B	403	4/4	0.94	0.07	17,18,18,18	0
3	EDO	A	403	4/4	0.96	0.06	11,12,12,12	4
2	MG	B	401	1/1	0.96	0.04	12,12,12,12	0
2	MG	A	401	1/1	0.98	0.05	11,11,11,11	0
2	MG	B	402	1/1	0.98	0.02	10,10,10,10	0
2	MG	A	402	1/1	0.99	0.05	12,12,12,12	0

6.5 Other polymers [i](#)

There are no such residues in this entry.