



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 22, 2020 – 01:30 pm BST

PDB ID : 5B2T  
Title : Crystal structure of the Streptococcus pyogenes Cas9 VRER variant in complex with sgRNA and target DNA (TGCG PAM)  
Authors : Hirano, S.; Nishimasu, H.; Ishitani, R.; Nureki, O.  
Deposited on : 2016-02-02  
Resolution : 2.20 Å(reported)

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

We welcome your comments at [validation@mail.wwpdb.org](mailto: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.

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

MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

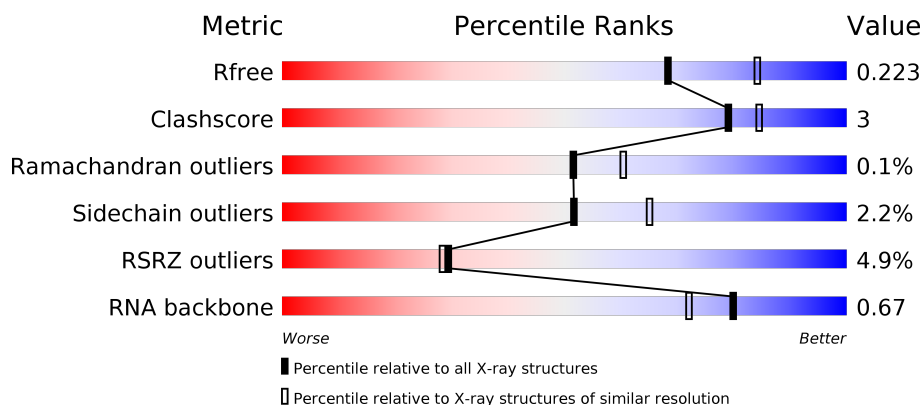
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.20 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))
$R_{free}$	130704	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)
RNA backbone	3102	1032 (2.60-1.80)

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 on the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 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	81	<div> <div>83%</div> <div>17%</div> </div>
2	B	1372	<div> <div>5%</div> <div>88%</div> <div>8%</div> <div>...</div> </div>
3	C	28	<div> <div>82%</div> <div>18%</div> </div>
4	D	8	<div> <div>88%</div> <div>13%</div> </div>

## 2 Entry composition

There are 9 unique types of molecules in this entry. The entry contains 13608 atoms, of which 0 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 RNA chain called Guide RNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	81	Total	C	N	O	P	0	0	0
			1739	778	319	561	81			

- Molecule 2 is a protein called CRISPR-associated endonuclease Cas9.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	1326	Total	C	N	O	S	0	0	0
			10499	6699	1812	1968	20			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-3	GLY	-	expression tag	UNP Q99ZW2
B	-2	SER	-	expression tag	UNP Q99ZW2
B	-1	GLY	-	expression tag	UNP Q99ZW2
B	0	HIS	-	expression tag	UNP Q99ZW2
B	10	ALA	ASP	engineered mutation	UNP Q99ZW2
B	80	LEU	CYS	engineered mutation	UNP Q99ZW2
B	574	GLU	CYS	engineered mutation	UNP Q99ZW2
B	840	ALA	HIS	engineered mutation	UNP Q99ZW2
B	1135	VAL	ASP	engineered mutation	UNP Q99ZW2
B	1218	ARG	GLY	engineered mutation	UNP Q99ZW2
B	1335	GLU	ARG	engineered mutation	UNP Q99ZW2
B	1337	ARG	THR	engineered mutation	UNP Q99ZW2

- Molecule 3 is a DNA chain called Target DNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	28	Total	C	N	O	P	0	0	0
			562	269	103	163	27			

- Molecule 4 is a DNA chain called Non-target DNA, DNA (5'-D(\*TP\*GP\*CP\*GP\*AP\*TP\*

TP\*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	8	Total	C	N	O	P	0	0	0
			163	79	29	48	7			

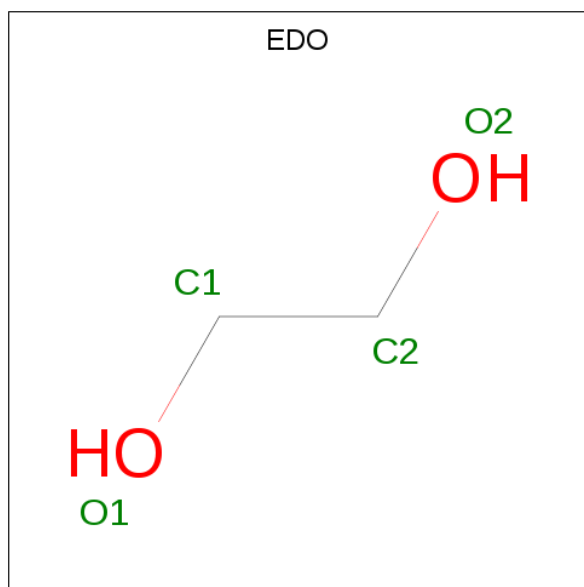
- Molecule 5 is POTASSIUM ION (three-letter code: K) (formula: K).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	B	7	Total	K	0	0
			7	7		
5	A	3	Total	K	0	0
			3	3		

- Molecule 6 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	3	Total	Mg	0	0
			3	3		

- Molecule 7 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C<sub>2</sub>H<sub>6</sub>O<sub>2</sub>).



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

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

- Molecule 8 is ACETATE ION (three-letter code: ACT) (formula:  $C_2H_3O_2$ ).



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

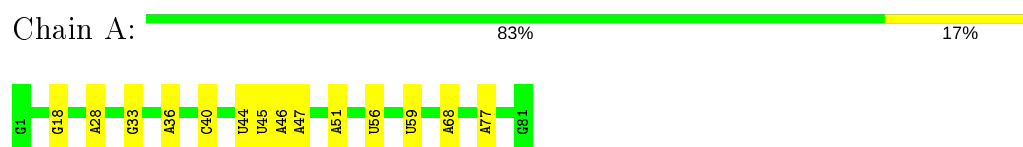
- Molecule 9 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	A	180	Total	O	0	0
			180	180		
9	B	387	Total	O	0	0
			387	387		
9	C	35	Total	O	0	0
			35	35		
9	D	6	Total	O	0	0
			6	6		

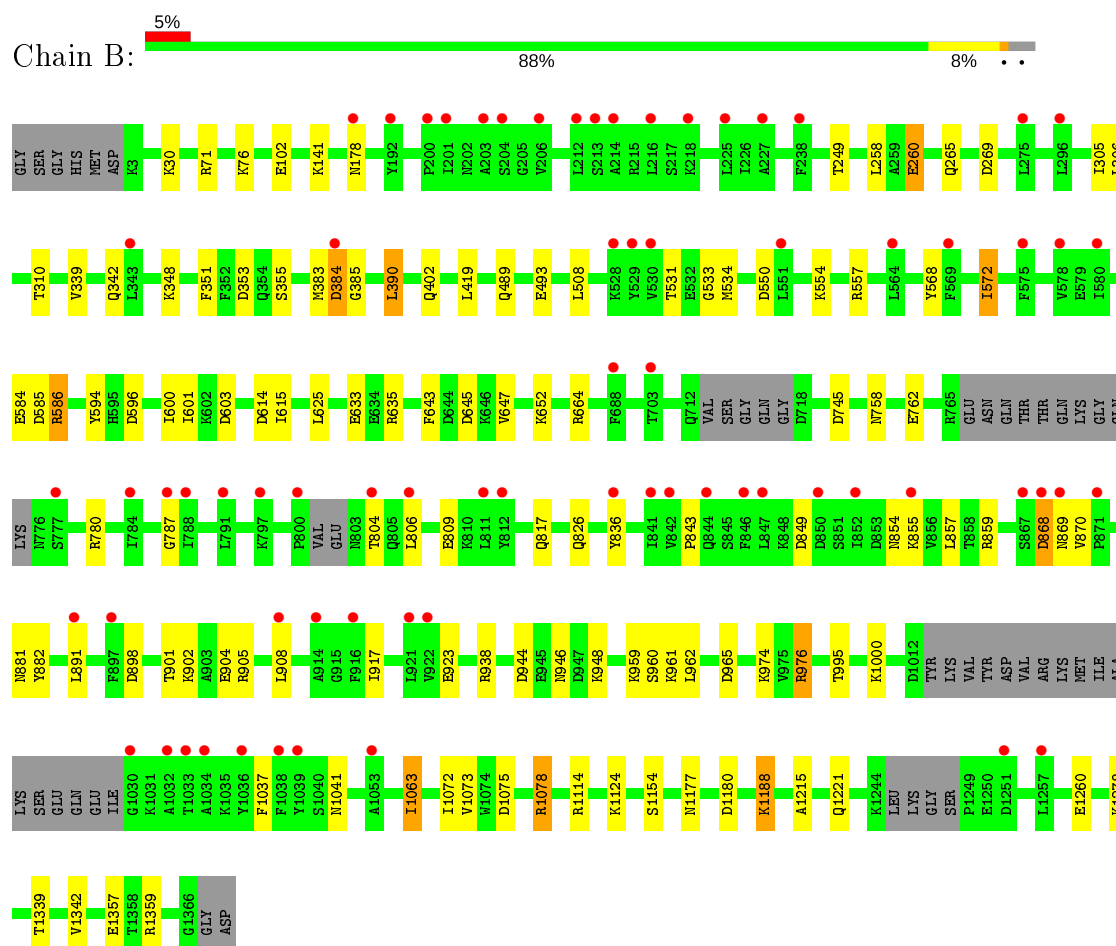
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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.

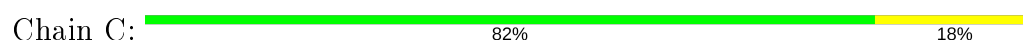
- Molecule 1: Guide RNA



- Molecule 2: CRISPR-associated endonuclease Cas9



- Molecule 3: Target DNA





- Molecule 4: Non-target DNA, DNA (5'-D(\*TP\*GP\*CP\*GP\*AP\*TP\*TP\*G)-3')

Chain D: 88% 13%



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	176.97Å 69.45Å 188.20Å 90.00° 109.67° 90.00°	Depositor
Resolution (Å)	49.01 – 2.20 49.01 – 2.20	Depositor EDS
% Data completeness (in resolution range)	94.5 (49.01-2.20) 94.5 (49.01-2.20)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.13 (at 2.20Å)	Xtriage
Refinement program	PHENIX 1.10 _2155: ???	Depositor
R, $R_{free}$	0.204 , 0.223 0.204 , 0.223	Depositor DCC
$R_{free}$ test set	5152 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	39.9	Xtriage
Anisotropy	0.364	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 38.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	13608	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	56.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.42% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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, K, EDO, ACT

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	0.16	0/1949	0.68	0/3037
2	B	0.24	0/10686	0.40	0/14425
3	C	0.51	0/629	0.91	0/966
4	D	0.53	0/182	0.98	0/280
All	All	0.25	0/13446	0.50	0/18708

There are no bond length outliers.

There are no bond angle outliers.

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	1739	0	870	5	0
2	B	10499	0	10347	65	0
3	C	562	0	315	3	0
4	D	163	0	93	1	0
5	A	3	0	0	0	0
5	B	7	0	0	0	0
6	A	3	0	0	0	0
7	A	4	0	6	0	0
7	B	16	0	24	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
8	A	4	0	3	0	0
9	A	180	0	0	0	0
9	B	387	0	0	3	0
9	C	35	0	0	0	0
9	D	6	0	0	0	0
All	All	13608	0	11658	70	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.

The worst 5 of 70 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)
2:B:1063:ILE:HD11	2:B:1072:ILE:HD12	1.64	0.79
2:B:817:GLN:O	2:B:882:TYR:OH	2.17	0.63
2:B:1357:GLU:OE1	2:B:1359:ARG:NH1	2.32	0.62
3:C:2:DA:H2'	3:C:3:DA:C8	2.39	0.58
2:B:1188:LYS:NZ	9:B:1505:HOH:O	2.36	0.58

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
2	B	1314/1372 (96%)	1278 (97%)	35 (3%)	1 (0%)	51 60

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	585	ASP

### 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
2	B	1103/1228 (90%)	1079 (98%)	24 (2%)	52 65

5 of 24 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	615	ILE
2	B	804	THR
2	B	1188	LYS
2	B	635	ARG
2	B	645	ASP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 6 such sidechains are listed below:

Mol	Chain	Res	Type
2	B	826	GLN
2	B	1317	ASN
2	B	881	ASN
2	B	402	GLN
2	B	1261	GLN

### 5.3.3 RNA [i](#)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	A	80/81 (98%)	7 (8%)	0

5 of 7 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	A	28	A
1	A	40	C
1	A	51	A
1	A	56	U
1	A	59	U

There are no RNA pucker outliers to report.

## 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 carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 19 ligands modelled in this entry, 13 are monoatomic - leaving 6 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	$\# Z  > 2$
7	EDO	B	1411	-	3,3,3	0.44	0	2,2,2	0.38	0
8	ACT	A	108	-	1,3,3	1.24	0	0,3,3	0.00	-
7	EDO	A	107	-	3,3,3	0.47	0	2,2,2	0.29	0
7	EDO	B	1410	-	3,3,3	0.46	0	2,2,2	0.36	0
7	EDO	B	1408	-	3,3,3	0.48	0	2,2,2	0.31	0
7	EDO	B	1409	-	3,3,3	0.45	0	2,2,2	0.28	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
7	EDO	B	1411	-	-	1/1/1/1	-
7	EDO	A	107	-	-	0/1/1/1	-
7	EDO	B	1408	-	-	0/1/1/1	-
7	EDO	B	1410	-	-	0/1/1/1	-
7	EDO	B	1409	-	-	0/1/1/1	-

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
7	B	1411	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
7	B	1409	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 [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	81/81 (100%)	-0.23	0 100 100	27, 45, 92, 101	0
2	B	1326/1372 (96%)	0.23	71 (5%) 25 24	27, 55, 97, 115	0
3	C	28/28 (100%)	-0.32	0 100 100	37, 53, 74, 75	0
4	D	8/8 (100%)	-0.06	0 100 100	39, 51, 88, 100	0
All	All	1443/1489 (96%)	0.19	71 (4%) 29 28	27, 55, 96, 115	0

The worst 5 of 71 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	871	PRO	4.9
2	B	1038	PHE	4.8
2	B	1030	GLY	4.8
2	B	868	ASP	4.3
2	B	530	VAL	4.1

### 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 carbohydrates 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, 95<sup>th</sup> 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( $\text{\AA}^2$ )	Q<0.9
5	K	B	1407	1/1	0.74	0.39	143,143,143,143	0
5	K	B	1405	1/1	0.86	0.11	70,70,70,70	0
8	ACT	A	108	4/4	0.89	0.22	52,53,54,54	0
6	MG	A	104	1/1	0.91	0.04	61,61,61,61	0
7	EDO	B	1409	4/4	0.93	0.24	48,48,49,49	0
7	EDO	B	1410	4/4	0.93	0.16	44,45,46,47	0
7	EDO	A	107	4/4	0.94	0.18	38,40,40,41	0
5	K	B	1406	1/1	0.94	0.05	101,101,101,101	0
6	MG	A	105	1/1	0.95	0.31	57,57,57,57	0
5	K	B	1403	1/1	0.95	0.14	70,70,70,70	0
5	K	B	1402	1/1	0.96	0.09	48,48,48,48	0
5	K	B	1401	1/1	0.97	0.07	49,49,49,49	0
7	EDO	B	1411	4/4	0.97	0.20	42,42,42,42	0
7	EDO	B	1408	4/4	0.97	0.18	37,38,39,40	0
5	K	B	1404	1/1	0.97	0.15	70,70,70,70	0
5	K	A	102	1/1	0.97	0.10	36,36,36,36	0
5	K	A	101	1/1	0.98	0.11	29,29,29,29	0
6	MG	A	106	1/1	0.98	0.17	49,49,49,49	0
5	K	A	103	1/1	0.99	0.10	39,39,39,39	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.