wwPDB X-ray Structure Validation Summary Report (i)

Mar 6, 2026 – 05:18 PM UTC

PDB ID	:	4YYK / pdb_00004yyk
Title	:	Crystal structure of BRD9 Bromodomain bound to a crotonyllysine peptide
Authors	:	Tang, Y.; Bellon, S.; Cochran, A.G.; Poy, F.
Deposited on	:	2015-03-24
Resolution	:	1.79 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) 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 (1)) were used in the production of this report:

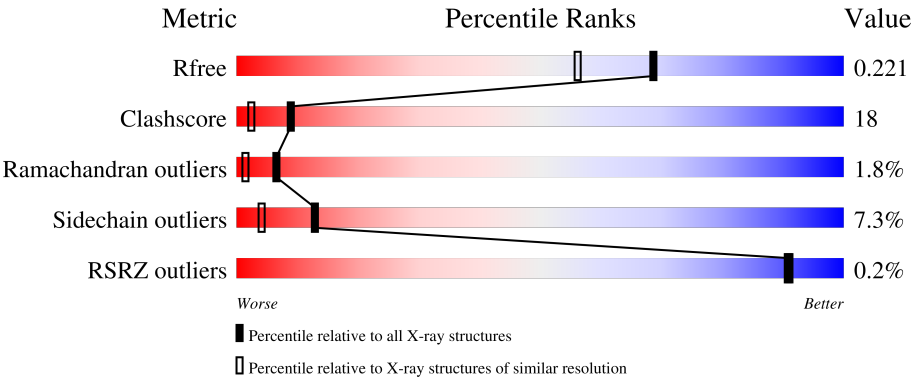
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.79 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}	180053	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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 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 <=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	108	49% 30% 15% 6%
1	B	108	% 46% 36% 11% 6%
1	D	108	35% 42% 17% 6%
1	E	108	34% 42% 16% • 6%
2	C	11	27% 9% 18% 45%

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Mol	Chain	Length	Quality of chain
2	F	11	36% 18% 45%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	KCR	F	8	-	-	X	-

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 3467 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 protein called Bromodomain-containing protein 9.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	101	Total	C	N	O	S	0	0	0
			821	534	136	143	8			
1	B	101	Total	C	N	O	S	0	0	0
			821	534	136	143	8			
1	D	101	Total	C	N	O	S	0	0	0
			821	534	136	143	8			
1	E	101	Total	C	N	O	S	0	0	0
			821	534	136	143	8			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	16	GLY	-	expression tag	UNP Q9H8M2
B	16	GLY	-	expression tag	UNP Q9H8M2
D	16	GLY	-	expression tag	UNP Q9H8M2
E	16	GLY	-	expression tag	UNP Q9H8M2

- Molecule 2 is a protein called Histone H4.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	C	6	Total	C	N	O	0	0	0
			44	28	8	8			
2	F	6	Total	C	N	O	0	0	0
			44	28	8	8			

- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	22	Total	O	0	0
			22	22		
3	B	21	Total	O	0	0
			21	21		

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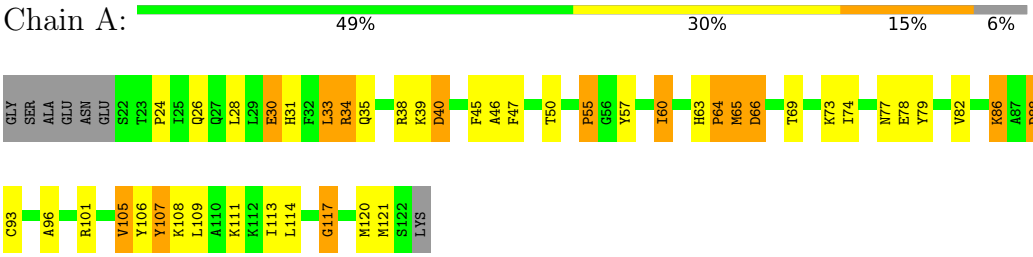
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	C	3	Total O 3 3	0	0
3	D	27	Total O 27 27	0	0
3	E	19	Total O 19 19	0	0
3	F	3	Total O 3 3	0	0

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.

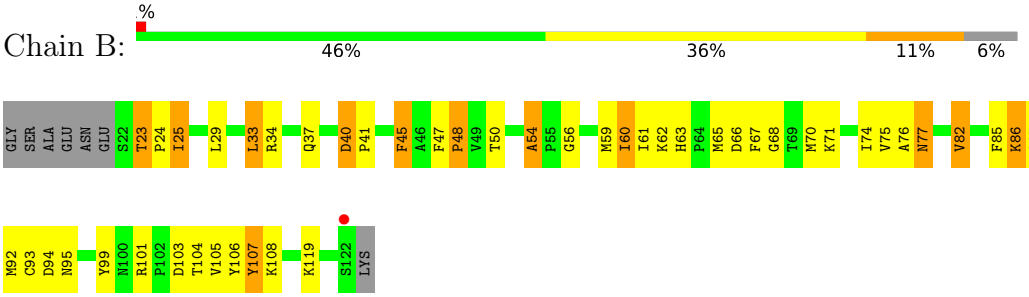
• Molecule 1: Bromodomain-containing protein 9

Chain A:



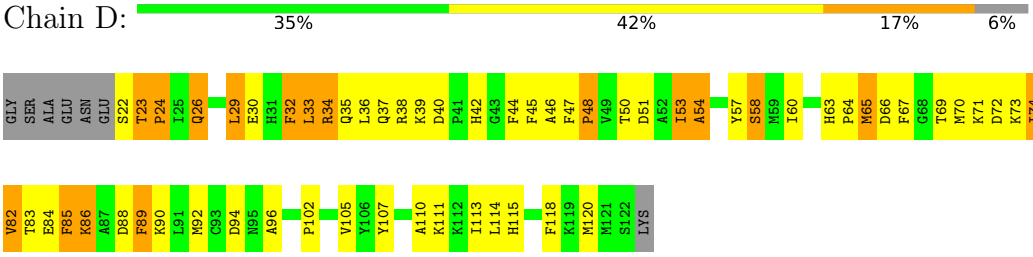
• Molecule 1: Bromodomain-containing protein 9

Chain B:



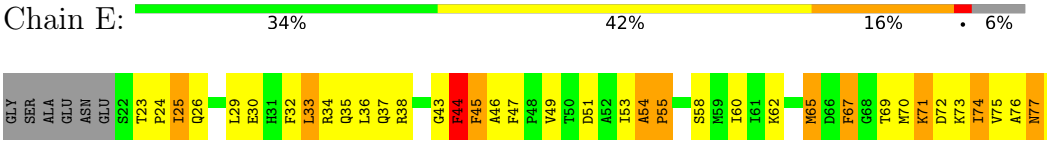
• Molecule 1: Bromodomain-containing protein 9

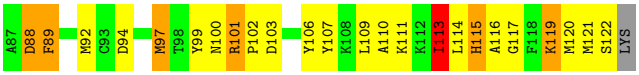
Chain D:



• Molecule 1: Bromodomain-containing protein 9

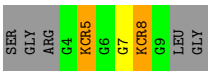
Chain E:





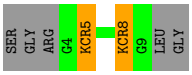
• Molecule 2: Histone H4

Chain C:



• Molecule 2: Histone H4

Chain F:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α, β, γ	24.84Å 34.73Å 129.08Å 89.88° 89.81° 69.45°	Depositor
Resolution (Å)	32.27 – 1.79 32.27 – 1.79	Depositor EDS
% Data completeness (in resolution range)	94.9 (32.27-1.79) 95.3 (32.27-1.79)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.40 (at 1.78Å)	Xtriage
Refinement program	REFMAC 5.8.0069	Depositor
R, R_{free}	0.225 , 0.261 0.195 , 0.221	Depositor DCC
R_{free} test set	1851 reflections (4.83%)	wwPDB-VP
Wilson B-factor (Å^2)	28.0	Xtriage
Anisotropy	0.059	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 28.2	EDS
L-test for twinning[2]	$< \|L\| > = 0.53$, $< L^2 > = 0.37$	Xtriage
Estimated twinning fraction	0.246 for h,h-k,-l 0.198 for -h,-k,l 0.186 for -h,-h+k,-l	Xtriage
Reported twinning fraction	0.879 for H, K, L 0.121 for H, H-K, -L	Depositor
Outliers	0 of 36333 reflections	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	3467	wwPDB-VP
Average B, all atoms (Å^2)	29.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 10.05% of the height of the origin peak. No significant pseudotranslation is detected.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: KCR

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	1.73	13/843 (1.5%)	1.77	19/1133 (1.7%)
1	B	2.03	25/843 (3.0%)	1.88	28/1133 (2.5%)
1	D	2.02	26/843 (3.1%)	2.06	29/1133 (2.6%)
1	E	1.91	24/843 (2.8%)	1.80	20/1133 (1.8%)
2	C	2.18	0/13	2.16	0/11
2	F	1.74	0/13	1.82	0/11
All	All	1.93	88/3398 (2.6%)	1.88	96/4554 (2.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand.A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	D	0	1

The worst 5 of 88 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	45	PHE	C-O	15.14	1.44	1.24
1	E	47	PHE	CA-C	11.08	1.63	1.52
1	A	66	ASP	C-O	9.40	1.35	1.23
1	A	65	MET	N-CA	9.30	1.57	1.45
1	D	89	PHE	N-CA	9.29	1.57	1.46

The worst 5 of 96 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	D	47	PHE	CA-C-N	-13.32	106.84	120.03
1	D	47	PHE	C-N-CA	-13.32	106.84	120.03

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	D	110	ALA	N-CA-C	-11.32	97.58	111.40
1	D	86	LYS	N-CA-C	9.62	122.65	111.11
1	A	108	LYS	N-CA-C	9.27	121.38	111.28

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	D	32	PHE	Mainchain

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	821	0	825	33	0
1	B	821	0	825	18	0
1	D	821	0	825	30	0
1	E	821	0	825	46	0
2	C	44	0	43	9	0
2	F	44	0	41	11	0
3	A	22	0	0	1	0
3	B	21	0	0	1	0
3	C	3	0	0	0	0
3	D	27	0	0	2	0
3	E	19	0	0	1	0
3	F	3	0	0	0	0
All	All	3467	0	3384	125	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 18.

The worst 5 of 125 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:E:109:LEU:O	1:E:113:ILE:HG22	1.42	1.16

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:45:PHE:CZ	2:C:5:KCR:H17	2.04	0.92
1:A:26:GLN:NE2	1:A:77:ASN:HD22	1.76	0.83
1:E:33:LEU:O	1:E:37:GLN:HG3	1.81	0.80
1:E:102:PRO:HA	1:E:107:TYR:CG	2.16	0.80

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	99/108 (92%)	87 (88%)	11 (11%)	1 (1%)	12 4
1	B	99/108 (92%)	90 (91%)	8 (8%)	1 (1%)	12 4
1	D	99/108 (92%)	90 (91%)	7 (7%)	2 (2%)	6 1
1	E	99/108 (92%)	85 (86%)	11 (11%)	3 (3%)	3 0
2	C	2/11 (18%)	2 (100%)	0	0	100 100
2	F	2/11 (18%)	2 (100%)	0	0	100 100
All	All	400/454 (88%)	356 (89%)	37 (9%)	7 (2%)	6 1

5 of 7 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	E	77	ASN
1	B	56	GLY
1	A	117	GLY
1	D	75	VAL
1	E	44	PHE

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	89/94 (95%)	84 (94%)	5 (6%)	19 8
1	B	89/94 (95%)	82 (92%)	7 (8%)	11 3
1	D	89/94 (95%)	80 (90%)	9 (10%)	7 2
1	E	89/94 (95%)	84 (94%)	5 (6%)	19 8
All	All	356/376 (95%)	330 (93%)	26 (7%)	13 4

5 of 26 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	53	ILE
1	D	64	PRO
1	E	111	LYS
1	D	60	ILE
1	D	65	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such sidechains are listed below:

Mol	Chain	Res	Type
1	D	77	ASN
1	E	31	HIS
1	E	37	GLN
1	B	77	ASN
1	B	115	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)

4 non-standard protein/DNA/RNA residues are modelled in this entry.

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	$\#\|Z\| > 2$
2	KCR	C	5	2	12,13,14	1.43	1 (8%)	9,14,16	3.99	4 (44%)
2	KCR	C	8	2	12,13,14	1.17	1 (8%)	9,14,16	2.55	3 (33%)
2	KCR	F	8	2	12,13,14	0.89	0	9,14,16	1.88	3 (33%)
2	KCR	F	5	2	12,13,14	1.11	1 (8%)	9,14,16	3.94	2 (22%)

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
2	KCR	C	5	2	-	4/12/13/15	-
2	KCR	C	8	2	-	6/12/13/15	-
2	KCR	F	8	2	-	2/12/13/15	-
2	KCR	F	5	2	-	3/12/13/15	-

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	5	KCR	OH-CH	-3.85	1.17	1.24
2	F	5	KCR	CX-CY	2.22	1.39	1.31
2	C	8	KCR	CX-CH	2.15	1.52	1.48

The worst 5 of 12 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	F	5	KCR	CY-CX-CH	-11.23	106.51	120.98
2	C	5	KCR	CY-CX-CH	-10.38	107.60	120.98
2	C	8	KCR	CY-CX-CH	-5.86	113.42	120.98
2	C	5	KCR	CX-CH-NZ	3.67	123.12	115.07
2	F	8	KCR	CY-CX-CH	-3.50	116.47	120.98

There are no chirality outliers.

5 of 15 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	C	5	KCR	O-C-CA-CB
2	C	8	KCR	N-CA-CB-CG
2	C	8	KCR	C-CA-CB-CG
2	C	5	KCR	OH-CH-CX-CY
2	F	5	KCR	OH-CH-CX-CY

There are no ring outliers.

4 monomers are involved in 19 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	5	KCR	3	0
2	C	8	KCR	5	0
2	F	8	KCR	8	0
2	F	5	KCR	3	0

5.5 Carbohydrates (i)

There are no oligosaccharides in this entry.

5.6 Ligand geometry (i)

There are no ligands in this entry.

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, 95^{th} 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	101/108 (93%)	0.34	0 100 100	16, 30, 41, 52	0
1	B	101/108 (93%)	0.20	1 (0%) 79 80	16, 28, 40, 53	0
1	D	101/108 (93%)	0.15	0 100 100	16, 26, 40, 47	0
1	E	101/108 (93%)	0.22	0 100 100	19, 29, 38, 47	0
2	C	4/11 (36%)	0.62	0 100 100	32, 32, 37, 37	0
2	F	4/11 (36%)	0.68	0 100 100	33, 33, 35, 44	0
All	All	412/454 (90%)	0.23	1 (0%) 91 91	16, 29, 42, 53	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	122	SER	2.4

6.2 Non-standard residues in protein, DNA, RNA chains

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^{th} 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(Å^2)	Q<0.9
2	KCR	C	5	14/15	0.83	0.13	30,41,49,53	0
2	KCR	F	8	14/15	0.87	0.11	31,40,54,58	0
2	KCR	C	8	14/15	0.90	0.09	26,32,38,39	0
2	KCR	F	5	14/15	0.93	0.07	24,29,33,33	0

6.3 Carbohydrates (i)

There are no oligosaccharides in this entry.

6.4 Ligands (i)

There are no ligands in this entry.

6.5 Other polymers (i)

There are no such residues in this entry.