



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 1, 2016 – 09:07 AM GMT

PDB ID : 3HAN  
Title : Crystal structure of bacteriorhodopsin mutant V49A crystallized from bicelles  
Authors : Joh, N.H.; Yang, D.; Bowie, J.U.  
Deposited on : 2009-05-02  
Resolution : 2.75 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](mailto:validation@mail.wwpdb.org)  
A user guide is available at  
<http://wwpdb.org/validation/2016/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 : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk26865

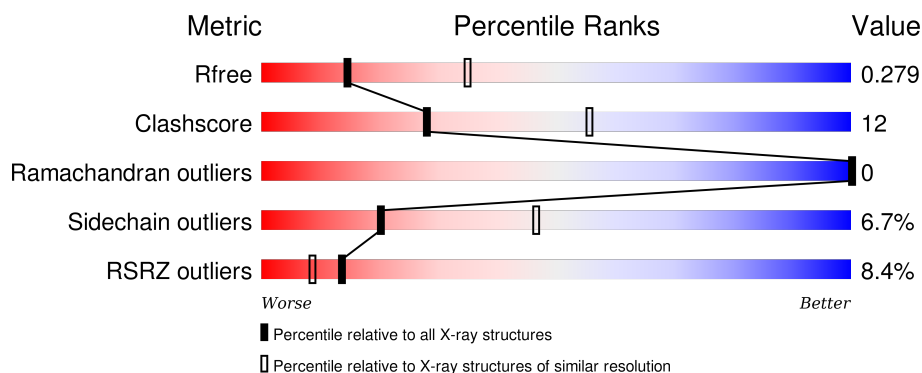
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.75 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))
$R_{free}$	91344	3340 (2.80-2.72)
Clashscore	102246	3829 (2.80-2.72)
Ramachandran outliers	100387	3767 (2.80-2.72)
Sidechain outliers	100360	3770 (2.80-2.72)
RSRZ outliers	91569	3352 (2.80-2.72)

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. 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	249	<div> <div>8%</div> <div>57%</div> <div>29%</div> <div>•</div> <div>10%</div> </div>

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	RET	A	301	-	-	X	-

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 1771 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.

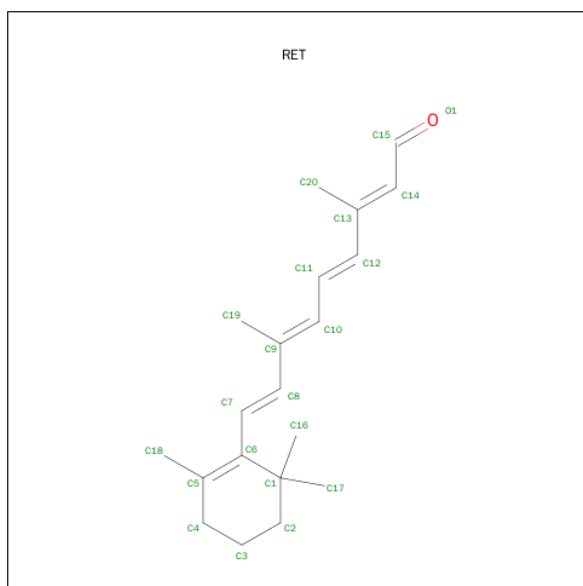
- Molecule 1 is a protein called Bacteriorhodopsin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	225	1743	1172	266	296	9	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	49	ALA	VAL	ENGINEERED	UNP P02945

- Molecule 2 is RETINAL (three-letter code: RET) (formula: C<sub>20</sub>H<sub>28</sub>O).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	C	0	0
			20	20		

- Molecule 3 is water.

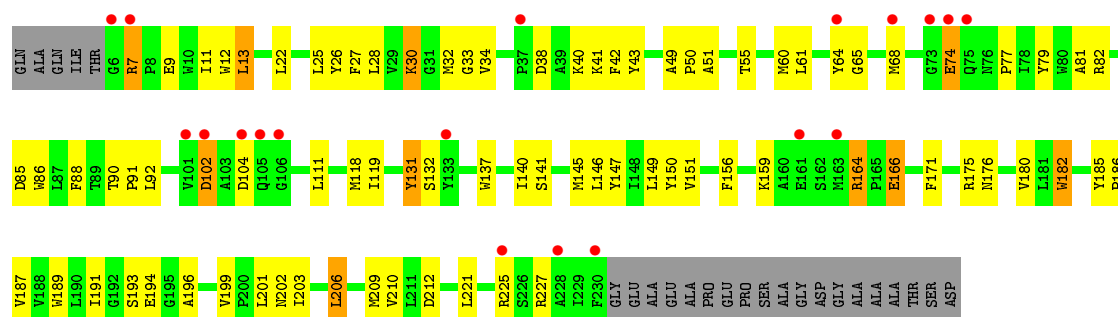
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	8	Total	O	0	0
			8	8		

### 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 errors 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: Bacteriorhodopsin

Chain A: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	44.95Å 102.88Å 128.42Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	41.20 – 2.75 41.19 – 2.75	Depositor EDS
% Data completeness (in resolution range)	89.4 (41.20-2.75) 89.4 (41.19-2.75)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.29 (at 2.73Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.222 , 0.282 0.219 , 0.279	Depositor DCC
$R_{free}$ test set	587 reflections (8.80%)	DCC
Wilson B-factor (Å <sup>2</sup> )	51.2	Xtriage
Anisotropy	0.232	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 44.5	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Outliers	1 of 7263 reflections (0.014%)	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	1771	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	40.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.95% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: RET

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	1.72	27/1791 (1.5%)	1.40	18/2446 (0.7%)

All (27) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	182	TRP	CB-CG	-9.67	1.32	1.50
1	A	131	TYR	CD2-CE2	8.82	1.52	1.39
1	A	137	TRP	CZ3-CH2	8.77	1.54	1.40
1	A	166	GLU	CG-CD	7.87	1.63	1.51
1	A	203	ILE	CA-CB	7.15	1.71	1.54
1	A	42	PHE	CE1-CZ	6.60	1.49	1.37
1	A	79	TYR	CD2-CE2	-6.39	1.29	1.39
1	A	64	TYR	CE2-CZ	6.19	1.46	1.38
1	A	147	TYR	CG-CD1	6.16	1.47	1.39
1	A	11	ILE	CA-CB	6.08	1.68	1.54
1	A	150	TYR	CG-CD2	6.08	1.47	1.39
1	A	140	ILE	CB-CG2	6.07	1.71	1.52
1	A	12	TRP	CE3-CZ3	5.88	1.48	1.38
1	A	137	TRP	CE3-CZ3	5.84	1.48	1.38
1	A	88	PHE	CE1-CZ	5.76	1.48	1.37
1	A	150	TYR	CE1-CZ	5.68	1.46	1.38
1	A	74	GLU	CB-CG	5.64	1.62	1.52
1	A	194	GLU	CB-CG	5.64	1.62	1.52
1	A	79	TYR	CG-CD1	5.63	1.46	1.39
1	A	82	ARG	CB-CG	-5.48	1.37	1.52
1	A	199	VAL	CA-CB	5.46	1.66	1.54
1	A	132	SER	CB-OG	-5.44	1.35	1.42
1	A	137	TRP	CD2-CE2	5.33	1.47	1.41
1	A	33	GLY	C-O	-5.26	1.15	1.23
1	A	26	TYR	CD1-CE1	5.23	1.47	1.39
1	A	196	ALA	CA-CB	-5.14	1.41	1.52

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	180	VAL	CB-CG1	5.10	1.63	1.52

All (18) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	212	ASP	CB-CG-OD2	11.77	128.89	118.30
1	A	212	ASP	CB-CG-OD1	-8.18	110.94	118.30
1	A	68	MET	CG-SD-CE	8.16	113.26	100.20
1	A	102	ASP	CB-CG-OD2	7.65	125.19	118.30
1	A	22	LEU	CB-CG-CD2	-7.64	98.01	111.00
1	A	92	LEU	CB-CG-CD1	-6.94	99.20	111.00
1	A	38	ASP	CB-CG-OD1	6.67	124.30	118.30
1	A	82	ARG	NE-CZ-NH2	-6.04	117.28	120.30
1	A	206	LEU	CA-CB-CG	6.00	129.11	115.30
1	A	61	LEU	CA-CB-CG	5.93	128.95	115.30
1	A	7	ARG	NE-CZ-NH1	5.69	123.14	120.30
1	A	25	LEU	CB-CG-CD1	-5.58	101.51	111.00
1	A	64	TYR	CB-CG-CD1	-5.50	117.70	121.00
1	A	149	LEU	CB-CG-CD1	-5.26	102.06	111.00
1	A	102	ASP	CB-CG-OD1	-5.16	113.65	118.30
1	A	60	MET	CG-SD-CE	5.09	108.34	100.20
1	A	146	LEU	CB-CG-CD1	-5.04	102.43	111.00
1	A	13	LEU	CB-CG-CD1	5.04	119.56	111.00

There are no chirality outliers.

There are no planarity outliers.

## 5.2 Too-close contacts ⓘ

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	1743	0	1799	37	0
2	A	20	0	27	9	0
3	A	8	0	0	2	0
All	All	1771	0	1826	42	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 12.

All (42) 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:A:51:ALA:O	1:A:55:THR:HG23	1.69	0.91
2:A:301:RET:H161	2:A:301:RET:H8	1.55	0.87
1:A:175:ARG:HH21	1:A:176:ASN:HD21	1.29	0.79
1:A:185:TYR:N	1:A:186:PRO:HD2	2.00	0.76
1:A:27:PHE:HE1	1:A:221:LEU:HD23	1.49	0.75
1:A:34:VAL:O	1:A:40:LYS:HE2	1.89	0.73
1:A:189:TRP:CD1	2:A:301:RET:H22	2.23	0.73
1:A:186:PRO:HB3	2:A:301:RET:H183	1.70	0.72
2:A:301:RET:C16	2:A:301:RET:H8	2.26	0.65
1:A:9:GLU:HB3	1:A:202:ASN:HA	1.79	0.65
1:A:27:PHE:CE1	1:A:221:LEU:HD23	2.34	0.63
2:A:301:RET:H161	2:A:301:RET:C8	2.26	0.63
2:A:301:RET:H8	2:A:301:RET:H171	1.82	0.60
1:A:30:LYS:HD3	1:A:43:TYR:OH	2.03	0.59
1:A:65:GLY:HA3	1:A:81:ALA:HB2	1.85	0.58
1:A:164:ARG:HB2	1:A:166:GLU:OE1	2.05	0.57
1:A:49:ALA:HB3	1:A:50:PRO:CD	2.37	0.55
1:A:30:LYS:O	1:A:34:VAL:HG23	2.07	0.54
1:A:118:MET:SD	1:A:145:MET:HB2	2.48	0.54
1:A:77:PRO:HD2	3:A:257:HOH:O	2.08	0.53
1:A:85:ASP:OD1	1:A:85:ASP:C	2.47	0.53
1:A:104:ASP:OD1	1:A:159:LYS:NZ	2.38	0.51
1:A:182:TRP:N	1:A:182:TRP:CD1	2.73	0.51
1:A:86:TRP:CD1	2:A:301:RET:H14	2.46	0.51
1:A:206:LEU:O	1:A:210:VAL:HG23	2.13	0.49
2:A:301:RET:C8	2:A:301:RET:H171	2.43	0.48
1:A:185:TYR:N	1:A:186:PRO:CD	2.72	0.48
1:A:185:TYR:H	1:A:186:PRO:HD2	1.77	0.47
1:A:171:PHE:O	1:A:175:ARG:N	2.37	0.46
1:A:90:THR:N	1:A:91:PRO:HD2	2.29	0.46
1:A:187:VAL:O	1:A:191:ILE:HG12	2.16	0.46
1:A:221:LEU:O	1:A:225:ARG:HG3	2.18	0.44
1:A:156:PHE:HB3	1:A:171:PHE:CZ	2.52	0.44
1:A:49:ALA:HB3	1:A:50:PRO:HD3	2.00	0.43
1:A:51:ALA:O	1:A:55:THR:CG2	2.54	0.42
1:A:141:SER:HB3	2:A:301:RET:H41	2.00	0.42
1:A:111:LEU:HD21	1:A:151:VAL:HG11	2.02	0.42
1:A:77:PRO:HG2	1:A:201:LEU:HD22	2.02	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:86:TRP:HB3	1:A:119:ILE:HD12	2.02	0.41
1:A:49:ALA:CB	1:A:50:PRO:CD	2.98	0.41
1:A:193:SER:HB2	3:A:257:HOH:O	2.20	0.41
1:A:145:MET:HG2	1:A:145:MET:O	2.17	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	223/249 (90%)	207 (93%)	16 (7%)	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	180/194 (93%)	168 (93%)	12 (7%)	20	46

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	7	ARG
1	A	13	LEU

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Mol	Chain	Res	Type
1	A	28	LEU
1	A	30	LYS
1	A	32	MET
1	A	41	LYS
1	A	74	GLU
1	A	102	ASP
1	A	131	TYR
1	A	164	ARG
1	A	209	MET
1	A	227	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	76	ASN
1	A	176	ASN

### 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 carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

1 ligand is 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	RET	A	301	1	19,20,21	1.64	4 (21%)	27,27,28	4.43	20 (74%)

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	RET	A	301	1	-	0/13/30/31	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	301	RET	C10-C9	-2.71	1.32	1.35
2	A	301	RET	C17-C1	2.11	1.58	1.53
2	A	301	RET	C12-C13	3.11	1.52	1.45
2	A	301	RET	C5-C6	3.54	1.40	1.34

All (20) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	301	RET	C17-C1-C16	-6.63	87.11	108.37
2	A	301	RET	C19-C9-C10	-6.29	113.62	122.90
2	A	301	RET	C17-C1-C6	-5.92	101.02	110.30
2	A	301	RET	C3-C4-C5	-5.25	105.54	113.87
2	A	301	RET	C17-C1-C2	-5.14	90.38	108.79
2	A	301	RET	C8-C9-C10	-4.59	111.58	118.98
2	A	301	RET	C18-C5-C6	-4.14	120.54	124.61
2	A	301	RET	C20-C13-C14	-4.06	110.91	123.36
2	A	301	RET	C7-C6-C5	-3.13	114.20	121.37
2	A	301	RET	C7-C8-C9	-2.41	122.55	126.22
2	A	301	RET	C11-C10-C9	-2.32	123.85	127.20
2	A	301	RET	C1-C6-C7	2.32	122.31	115.82
2	A	301	RET	C11-C12-C13	2.47	133.57	126.32
2	A	301	RET	C18-C5-C4	2.84	118.81	113.43
2	A	301	RET	C2-C1-C6	3.15	115.35	110.36
2	A	301	RET	C2-C3-C4	3.34	119.95	111.53
2	A	301	RET	C16-C1-C2	3.73	122.13	108.79
2	A	301	RET	C16-C1-C6	7.37	121.85	110.30
2	A	301	RET	C20-C13-C12	7.98	131.38	118.10
2	A	301	RET	C19-C9-C8	10.02	134.78	118.10

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 9 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	301	RET	9	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	225/249 (90%)	0.33	19 (8%) 14 9	25, 38, 58, 74	0

All (19) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	6	GLY	10.2
1	A	102	ASP	4.3
1	A	75	GLN	4.2
1	A	73	GLY	4.0
1	A	106	GLY	3.9
1	A	68	MET	3.8
1	A	105	GLN	3.6
1	A	7	ARG	3.6
1	A	161	GLU	3.1
1	A	104	ASP	3.1
1	A	225	ARG	3.0
1	A	64	TYR	2.9
1	A	37	PRO	2.9
1	A	101	VAL	2.8
1	A	133	TYR	2.7
1	A	74	GLU	2.5
1	A	228	ALA	2.4
1	A	163	MET	2.2
1	A	230	PHE	2.1

### 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
2	RET	A	301	20/21	0.92	0.17	0.24	19,30,42,45	0

### 6.5 Other polymers [i](#)

There are no such residues in this entry.