



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 24, 2017 – 07:43 AM EDT

PDB ID : 5KBW  
Title : Crystal structure of TmRibU, the riboflavin-binding S subunit from the *Thermotoga maritima* ECF transporter  
Authors : Karpowich, N.K.; Wang, D.N.; Song, J.M.  
Deposited on : unknown  
Resolution : 2.61 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 : 1.7.2 (RC1), CSD as538be (2017)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20030345  
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)  
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) : rb-20030345

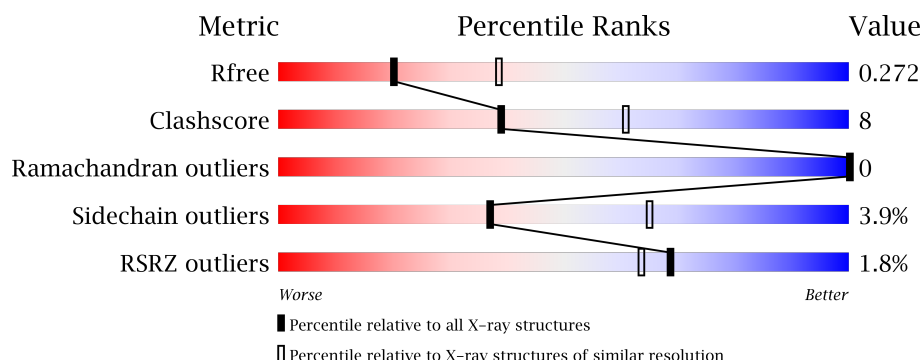
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.61 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))
$R_{free}$	100719	2542 (2.60-2.60)
Clashscore	112137	2895 (2.60-2.60)
Ramachandran outliers	110173	2848 (2.60-2.60)
Sidechain outliers	110143	2848 (2.60-2.60)
RSRZ outliers	101464	2550 (2.60-2.60)

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	181	<div> <div>2%</div> <div> <div></div> <div>83%</div> <div>10%</div> <div>6%</div> </div> </div>
1	B	181	<div> <div>2%</div> <div> <div></div> <div>69%</div> <div>23%</div> <div>6%</div> </div> </div>

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2703 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.

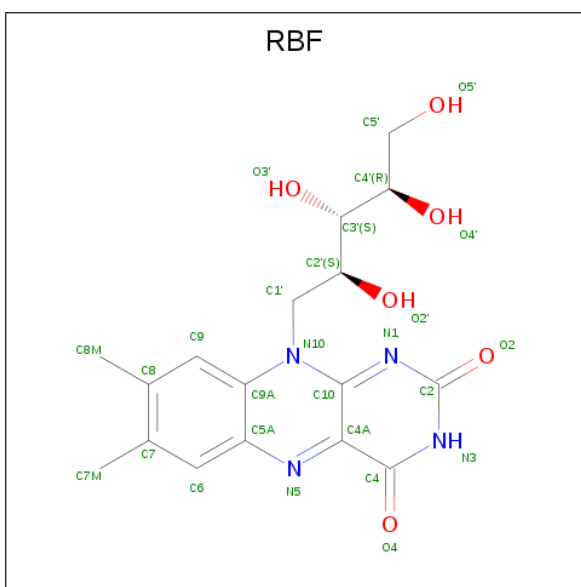
- Molecule 1 is a protein called Riboflavin transporter RibU.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	170	Total	C	N	O	S	0	0	0
			1317	903	194	214	6			
1	B	171	Total	C	N	O	S	0	0	0
			1326	909	196	215	6			

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	0	MET	-	initiating methionine	UNP Q9X1G6
A	1	GLY	-	expression tag	UNP Q9X1G6
A	174	SER	-	expression tag	UNP Q9X1G6
A	175	ASN	-	expression tag	UNP Q9X1G6
A	176	SER	-	expression tag	UNP Q9X1G6
A	177	LEU	-	expression tag	UNP Q9X1G6
A	178	VAL	-	expression tag	UNP Q9X1G6
A	179	PRO	-	expression tag	UNP Q9X1G6
A	180	ARG	-	expression tag	UNP Q9X1G6
B	0	MET	-	initiating methionine	UNP Q9X1G6
B	1	GLY	-	expression tag	UNP Q9X1G6
B	174	SER	-	expression tag	UNP Q9X1G6
B	175	ASN	-	expression tag	UNP Q9X1G6
B	176	SER	-	expression tag	UNP Q9X1G6
B	177	LEU	-	expression tag	UNP Q9X1G6
B	178	VAL	-	expression tag	UNP Q9X1G6
B	179	PRO	-	expression tag	UNP Q9X1G6
B	180	ARG	-	expression tag	UNP Q9X1G6

- Molecule 2 is RIBOFLAVIN (three-letter code: RBF) (formula: C<sub>17</sub>H<sub>20</sub>N<sub>4</sub>O<sub>6</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	N	O	0	0
			27	17	4	6		
2	B	1	Total	C	N	O	0	0
			27	17	4	6		

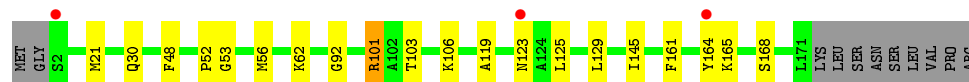
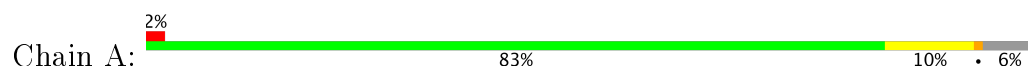
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	O	0	0
			1	1		
3	B	5	Total	O	0	0
			5	5		

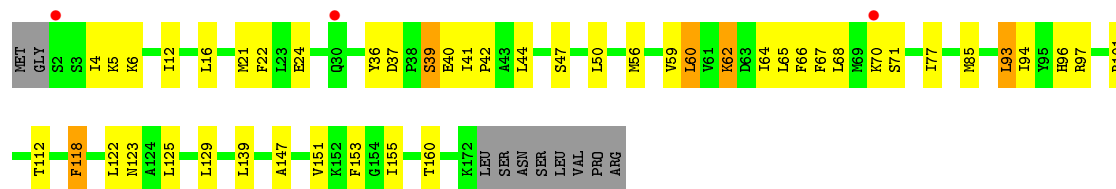
### 3 Residue-property plots [i](#)

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: Riboflavin transporter RibU



- Molecule 1: Riboflavin transporter RibU



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	40.14Å 94.36Å 50.99Å 90.00° 95.81° 90.00°	Depositor
Resolution (Å)	30.48 – 2.61 47.18 – 2.61	Depositor EDS
% Data completeness (in resolution range)	87.3 (30.48-2.61) 93.1 (47.18-2.61)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.08	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.42 (at 2.61Å)	Xtriage
Refinement program	PHENIX (1.10.1 _2155: ???)	Depositor
R, $R_{free}$	0.202 , 0.265 0.206 , 0.272	Depositor DCC
$R_{free}$ test set	533 reflections (4.94%)	DCC
Wilson B-factor (Å <sup>2</sup> )	45.7	Xtriage
Anisotropy	0.364	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 57.8	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	0.93	EDS
Total number of atoms	2703	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	59.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.17% 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

### 5.1 Standard geometry

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

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	0.30	0/1353	0.47	0/1833
1	B	0.29	0/1362	0.43	0/1844
All	All	0.29	0/2715	0.45	0/3677

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

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	1317	0	1393	15	0
1	B	1326	0	1407	31	0
2	A	27	0	18	3	0
2	B	27	0	20	1	0
3	A	1	0	0	0	0
3	B	5	0	0	0	0
All	All	2703	0	2838	47	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 8.

All (47) 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:22:PHE:HE1	1:B:70:LYS:HG3	1.51	0.75
1:B:37:ASP:OD1	1:B:39:SER:OG	2.09	0.69
1:A:103:THR:HA	1:A:106:LYS:HG2	1.75	0.69
1:B:118:PHE:HE2	1:B:122:LEU:HD22	1.57	0.68
1:B:118:PHE:CE2	1:B:122:LEU:HD22	2.34	0.61
1:B:21:MET:HB3	1:B:39:SER:OG	2.01	0.61
1:A:123:ASN:HB3	1:A:145:ILE:HD13	1.83	0.60
1:B:44:LEU:HG	1:B:160:THR:HG21	1.86	0.57
1:B:59:VAL:HA	1:B:62:LYS:HE3	1.86	0.57
2:A:201:RBF:HC2'	2:A:201:RBF:HC9	1.89	0.55
1:B:36:TYR:OH	1:B:155:ILE:HD11	2.07	0.55
1:A:101:ARG:HG3	1:A:161:PHE:CE1	2.42	0.55
1:A:125:LEU:O	1:A:129:LEU:HD23	2.09	0.53
1:B:56:MET:HB3	1:B:85:MET:HG2	1.89	0.52
1:A:52:PRO:O	1:A:56:MET:HG3	2.10	0.51
1:A:101:ARG:NH1	1:A:164:TYR:OH	2.43	0.51
1:A:123:ASN:OD1	2:A:201:RBF:HC6	2.10	0.50
1:A:30:GLN:N	1:A:30:GLN:OE1	2.43	0.49
1:B:12:ILE:O	1:B:16:LEU:HG	2.12	0.49
1:B:47:SER:O	1:B:96:HIS:NE2	2.42	0.49
1:A:48:PHE:CD2	1:A:164:TYR:CE1	3.02	0.47
1:A:53:GLY:HA3	1:B:139:LEU:O	2.14	0.47
1:B:64:ILE:O	1:B:68:LEU:HG	2.14	0.47
1:B:93:LEU:HD23	1:B:94:ILE:HD13	1.96	0.46
1:B:125:LEU:O	1:B:129:LEU:HG	2.15	0.46
1:B:60:LEU:O	1:B:64:ILE:HG23	2.16	0.45
1:B:67:PHE:HD1	1:B:77:ILE:HD12	1.81	0.45
1:B:112:THR:HG23	1:B:153:PHE:HB2	1.98	0.45
1:B:22:PHE:CE1	1:B:70:LYS:HG3	2.42	0.45
1:A:48:PHE:HD2	1:A:164:TYR:CE1	2.36	0.44
1:A:119:ALA:O	1:A:123:ASN:HB2	2.17	0.44
1:B:4:ILE:HD12	1:B:5:LYS:HD2	1.98	0.44
1:A:165:LYS:HA	1:A:165:LYS:HD2	1.68	0.43
1:B:122:LEU:HA	1:B:122:LEU:HD12	1.81	0.43
1:B:21:MET:HA	1:B:37:ASP:HB2	2.01	0.43
1:B:123:ASN:OD1	2:B:201:RBF:HC6	2.19	0.42
1:B:71:SER:HB3	1:B:77:ILE:HD11	1.99	0.42
1:B:64:ILE:HG13	1:B:65:LEU:N	2.32	0.42
1:B:40:GLU:H	1:B:40:GLU:CD	2.22	0.42
1:B:6:LYS:HD2	1:B:50:LEU:HD21	2.02	0.42
1:B:147:ALA:O	1:B:151:VAL:HG23	2.20	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:21:MET:HG3	1:B:66:PHE:CD1	2.55	0.41
2:A:201:RBF:C9	2:A:201:RBF:HC2'	2.50	0.41
1:A:101:ARG:HA	1:A:101:ARG:HD2	1.72	0.40
1:A:52:PRO:HG3	1:A:92:GLY:C	2.42	0.40
1:B:41:ILE:HB	1:B:42:PRO:HD3	2.03	0.40
1:B:24:GLU:HA	1:B:36:TYR:O	2.21	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	168/181 (93%)	162 (96%)	6 (4%)	0	100	100
1	B	169/181 (93%)	163 (96%)	6 (4%)	0	100	100
All	All	337/362 (93%)	325 (96%)	12 (4%)	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	142/152 (93%)	138 (97%)	4 (3%)	49	76
1	B	143/152 (94%)	136 (95%)	7 (5%)	29	54

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
All	All	285/304 (94%)	274 (96%)	11 (4%)	37 65

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	21	MET
1	A	62	LYS
1	A	101	ARG
1	A	168	SER
1	B	39	SER
1	B	60	LEU
1	B	62	LYS
1	B	93	LEU
1	B	97	ARG
1	B	101	ARG
1	B	118	PHE

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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

## 5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

2 ligands 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	RBF	A	201	1	27,29,29	1.54	5 (18%)	32,43,43	3.74	12 (37%)
2	RBF	B	201	-	27,29,29	1.69	7 (25%)	32,43,43	3.80	8 (25%)

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	RBF	A	201	1	-	0/12/14/14	0/3/3/3
2	RBF	B	201	-	-	0/12/14/14	0/3/3/3

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	201	RBF	C4A-C10	-4.18	1.33	1.41
2	A	201	RBF	C4A-C10	-3.45	1.34	1.41
2	B	201	RBF	O4-C4	-3.13	1.16	1.24
2	A	201	RBF	C9A-C5A	-2.74	1.36	1.42
2	B	201	RBF	C9A-N10	-2.52	1.35	1.38
2	B	201	RBF	O2'-C2'	-2.32	1.38	1.43
2	A	201	RBF	O2'-C2'	-2.28	1.38	1.43
2	B	201	RBF	C9A-C5A	-2.25	1.37	1.42
2	A	201	RBF	C8M-C8	2.25	1.55	1.51
2	B	201	RBF	C10-N1	2.50	1.36	1.33
2	A	201	RBF	C10-N1	3.04	1.37	1.33
2	B	201	RBF	C4A-N5	3.29	1.38	1.33

All (20) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	201	RBF	C1'-N10-C10	-11.08	107.14	118.50
2	A	201	RBF	C1'-N10-C10	-9.36	108.91	118.50
2	A	201	RBF	C4A-C4-N3	-4.28	117.38	123.48
2	B	201	RBF	C7M-C7-C6	-2.56	113.93	120.34
2	B	201	RBF	C4A-C4-N3	-2.45	120.00	123.48
2	A	201	RBF	C7M-C7-C6	-2.40	114.33	120.34
2	A	201	RBF	C4A-C10-N10	-2.32	118.91	120.52

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	201	RBF	C9-C9A-C5A	-2.25	115.68	119.58
2	A	201	RBF	C6-C5A-C9A	2.35	122.06	119.00
2	A	201	RBF	C5A-C9A-N10	2.44	119.47	117.66
2	B	201	RBF	C5A-C9A-N10	2.53	119.54	117.66
2	B	201	RBF	C7M-C7-C8	2.58	126.12	120.72
2	A	201	RBF	C7M-C7-C8	2.91	126.82	120.72
2	B	201	RBF	C4A-N5-C5A	3.14	120.08	116.76
2	A	201	RBF	C4-C4A-C10	3.43	122.74	119.96
2	A	201	RBF	C4A-N5-C5A	4.27	121.27	116.76
2	B	201	RBF	C4-N3-C2	5.62	120.07	115.16
2	A	201	RBF	C4-N3-C2	5.96	120.37	115.16
2	A	201	RBF	C1'-N10-C9A	14.97	132.06	118.35
2	B	201	RBF	C1'-N10-C9A	16.20	133.19	118.35

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	201	RBF	3	0
2	B	201	RBF	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	170/181 (93%)	-0.04	3 (1%) 69 63	39, 57, 77, 102	0
1	B	171/181 (94%)	-0.09	3 (1%) 69 63	43, 56, 76, 90	0
All	All	341/362 (94%)	-0.06	6 (1%) 69 63	39, 57, 77, 102	0

All (6) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	2	SER	3.7
1	A	164	TYR	3.1
1	B	2	SER	3.1
1	B	70	LYS	2.2
1	A	123	ASN	2.2
1	B	30	GLN	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 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	RBF	B	201	27/27	0.92	0.19	1.14	41,54,86,112	0
2	RBF	A	201	27/27	0.87	0.24	1.07	38,65,94,112	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.