



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 03:09 AM UTC

PDB ID : 4CUG / pdb_00004cug
Title : Rhodothermus marinus YCFD-like ribosomal protein L16 Arginyl hydroxylase
in complex substrate fragment
Authors : McDonough, M.A.; Sekirnik, R.; Schofield, C.J.
Deposited on : 2014-03-18
Resolution : 2.96 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 Phenix2.0
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

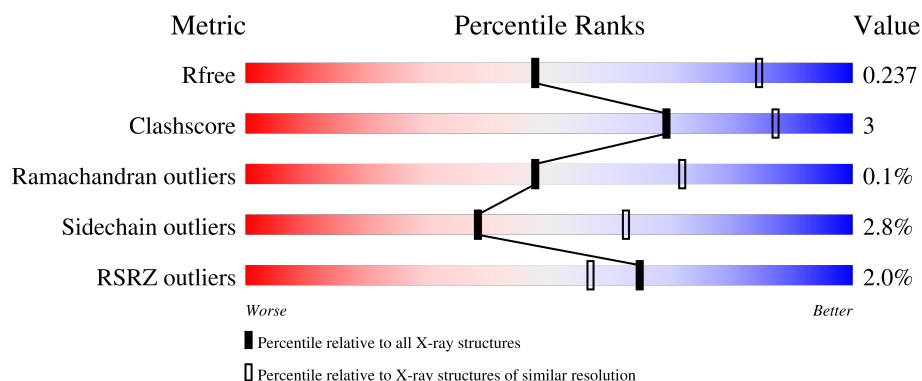
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.96 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	1130 (2.98-2.94)
Clashscore	190562	1157 (2.98-2.94)
Ramachandran outliers	187476	1101 (2.98-2.94)
Sidechain outliers	187428	1101 (2.98-2.94)
RSRZ outliers	180081	1130 (2.98-2.94)

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	406	2% 86% 8% • •
1	B	406	% 83% 11% • 5%
2	E	20	20% 35% 5% 60%
2	F	20	45% 55%

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 6278 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 CUPIN 4 FAMILY PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	388	Total	C	N	O	S	0	1	0
			3081	1978	540	556	7			
1	B	385	Total	C	N	O	S	0	1	0
			3029	1951	524	547	7			

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-13	HIS	-	expression tag	UNP D0MK34
A	-12	HIS	-	expression tag	UNP D0MK34
A	-11	HIS	-	expression tag	UNP D0MK34
A	-10	HIS	-	expression tag	UNP D0MK34
A	-9	SER	-	expression tag	UNP D0MK34
A	-8	SER	-	expression tag	UNP D0MK34
A	-7	GLY	-	expression tag	UNP D0MK34
A	-6	LEU	-	expression tag	UNP D0MK34
A	-5	VAL	-	expression tag	UNP D0MK34
A	-4	PRO	-	expression tag	UNP D0MK34
A	-3	ARG	-	expression tag	UNP D0MK34
A	-2	GLY	-	expression tag	UNP D0MK34
A	-1	SER	-	expression tag	UNP D0MK34
A	0	HIS	-	expression tag	UNP D0MK34
B	-13	HIS	-	expression tag	UNP D0MK34
B	-12	HIS	-	expression tag	UNP D0MK34
B	-11	HIS	-	expression tag	UNP D0MK34
B	-10	HIS	-	expression tag	UNP D0MK34
B	-9	SER	-	expression tag	UNP D0MK34
B	-8	SER	-	expression tag	UNP D0MK34
B	-7	GLY	-	expression tag	UNP D0MK34
B	-6	LEU	-	expression tag	UNP D0MK34
B	-5	VAL	-	expression tag	UNP D0MK34
B	-4	PRO	-	expression tag	UNP D0MK34
B	-3	ARG	-	expression tag	UNP D0MK34

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Chain	Residue	Modelled	Actual	Comment	Reference
B	-2	GLY	-	expression tag	UNP D0MK34
B	-1	SER	-	expression tag	UNP D0MK34
B	0	HIS	-	expression tag	UNP D0MK34

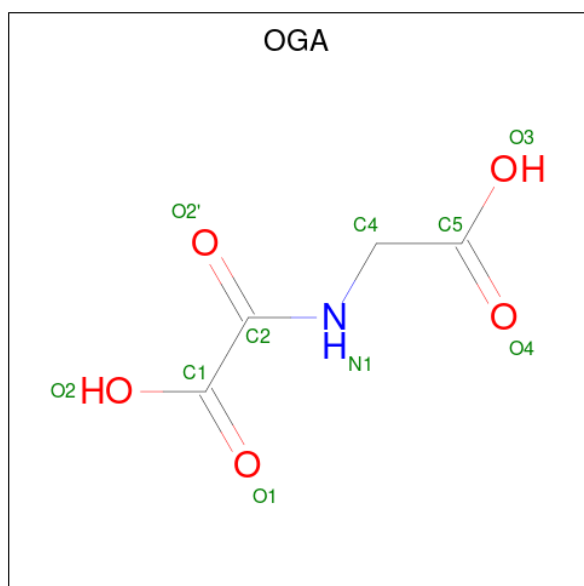
- Molecule 2 is a protein called 50S RIBOSOMAL PROTEIN L16.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	E	8	Total	C	N	O	S	0	0	0
			60	37	12	10	1			
2	F	9	Total	C	N	O	S	0	0	0
			65	40	13	11	1			

- Molecule 3 is MANGANESE (II) ION (CCD ID: MN) (formula: Mn).

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

- Molecule 4 is N-OXALYLGLYCINE (CCD ID: OGA) (formula: C₄H₅NO₅).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	N	O	0	0
			10	4	1	5		

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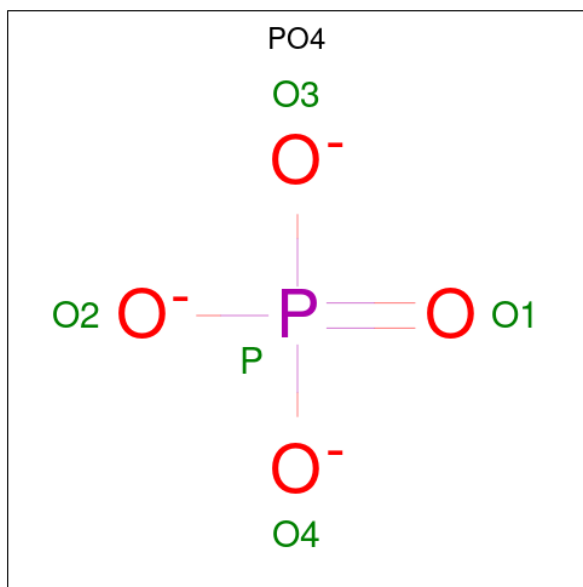
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	B	1	Total	C	N	O	0	0
			10	4	1	5		

- Molecule 5 is (4S)-2-METHYL-2,4-PENTANEDIOL (CCD ID: MPD) (formula: C₆H₁₄O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			8	6	2		
5	B	1	Total	C	O	0	0
			8	6	2		

- Molecule 6 is PHOSPHATE ION (CCD ID: PO4) (formula: O₄P).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	O	P	0	0
			5	4	1		

● Molecule 1: CUPIN 4 FAMILY PROTEIN



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	98.22Å 117.47Å 120.28Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	58.74 – 2.96 58.74 – 2.96	Depositor EDS
% Data completeness (in resolution range)	99.9 (58.74-2.96) 98.0 (58.74-2.96)	Depositor EDS
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.60 (at 2.96Å)	Xtriage
Refinement program	PHENIX (PHENIX.REFINE)	Depositor
R, R_{free}	0.210 , 0.227 0.220 , 0.237	Depositor DCC
R_{free} test set	2001 reflections (6.76%)	wwPDB-VP
Wilson B-factor (Å ²)	93.8	Xtriage
Anisotropy	0.111	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.29 , 56.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.023 for -h,l,k	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	6278	wwPDB-VP
Average B, all atoms (Å ²)	106.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.58% 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: PO4, MPD, MN, OGA

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	0.33	0/3172	0.63	0/4340
1	B	0.32	0/3119	0.63	0/4271
2	E	0.28	0/60	0.62	0/77
2	F	0.29	0/65	0.79	0/85
All	All	0.33	0/6416	0.63	0/8773

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	A	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	243	PRO	Peptide

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	3081	0	3050	20	0
1	B	3029	0	2977	26	0
2	E	60	0	65	1	0
2	F	65	0	66	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	10	0	3	0	0
4	B	10	0	3	0	0
5	A	8	0	14	2	0
5	B	8	0	14	1	0
6	A	5	0	0	0	0
All	All	6278	0	6192	43	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 (43) 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:97:LEU:HD21	1:B:287:LEU:HD11	1.65	0.79
1:B:160:GLU:OE1	1:B:169:ARG:NH1	2.24	0.71
1:B:109:ARG:NH2	1:B:353:GLY:O	2.26	0.68
1:A:269:ARG:NH2	1:B:256:ASP:OD1	2.28	0.67
1:A:109:ARG:NH1	1:A:113:ASN:OD1	2.31	0.64
1:A:160:GLU:OE2	1:A:169:ARG:NH1	2.31	0.62
1:B:147:ARG:NE	1:B:202:GLU:OE1	2.35	0.60
1:B:22:GLN:NE2	1:B:138:ASP:OD1	2.36	0.57
1:B:181:ILE:HD12	1:B:181:ILE:O	2.05	0.56
1:A:262:LEU:HD13	1:B:266:ILE:HD12	1.88	0.56
1:A:109:ARG:NH2	1:A:353:GLY:O	2.42	0.52
1:A:285:ARG:NH2	2:E:83:MET:O	2.43	0.52
1:B:7:ILE:HG12	1:B:8:LEU:H	1.75	0.52
1:B:97:LEU:CD2	1:B:287:LEU:HD11	2.35	0.52
1:B:344:LEU:HD23	1:B:344:LEU:H	1.76	0.51
1:B:83:PRO:O	1:B:87:TRP:NE1	2.44	0.51
1:B:370:ASP:OD1	1:B:371:PHE:N	2.44	0.50
1:A:96:ARG:NH2	1:A:117:ASP:O	2.44	0.50
1:A:100:GLU:N	1:A:100:GLU:OE1	2.44	0.49
1:A:18:ALA:O	1:A:23:LYS:NZ	2.43	0.48
1:A:218:GLU:HB3	5:A:1392:MPD:H52	1.96	0.47
1:A:108:VAL:HG11	1:A:211:PHE:HZ	1.80	0.46
1:A:348:ALA:HB3	1:A:349:PRO:HD3	1.96	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:333:ALA:HB1	1:A:383:ILE:HG12	1.98	0.46
1:A:14:GLU:OE1	1:A:14:GLU:N	2.43	0.46
1:A:97:LEU:HD21	1:A:287:LEU:HD11	1.99	0.45
1:B:129:THR:OG1	1:B:198:GLY:O	2.26	0.45
1:A:30:GLN:H	1:A:186:ASP:HB3	1.81	0.45
1:A:223:MET:N	1:A:224:PRO:CD	2.80	0.45
1:B:212:ARG:NH1	1:B:218:GLU:OE2	2.48	0.44
1:A:314:ASN:ND2	1:A:382:GLY:O	2.45	0.44
1:B:109:ARG:NH1	1:B:113:ASN:OD1	2.50	0.44
1:B:223:MET:N	1:B:224:PRO:CD	2.81	0.43
1:A:214:PRO:HA	5:A:1392:MPD:HM1	2.01	0.43
1:A:213:ALA:HB1	1:B:236:TYR:HB3	2.00	0.43
1:B:218:GLU:HB3	5:B:1391:MPD:H31	2.01	0.42
1:B:316:ILE:N	1:B:317:PRO:CD	2.82	0.42
1:B:227:ALA:HA	1:B:230:LEU:HD12	2.00	0.42
1:B:163:VAL:HB	1:B:166:LEU:HD12	2.01	0.42
1:B:341:SER:OG	1:B:343:GLU:OE1	2.36	0.42
1:B:67:TRP:HB2	1:B:166:LEU:HD22	2.03	0.41
1:B:350:LEU:HD11	1:B:361:THR:CG2	2.50	0.41
1:B:79:PHE:HA	1:B:82:LEU:HD12	2.02	0.41

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	387/406 (95%)	371 (96%)	16 (4%)	0	100	100
1	B	382/406 (94%)	364 (95%)	17 (4%)	1 (0%)	36	59
2	E	6/20 (30%)	6 (100%)	0	0	100	100
2	F	7/20 (35%)	6 (86%)	1 (14%)	0	100	100
All	All	782/852 (92%)	747 (96%)	34 (4%)	1 (0%)	48	72

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	7	ILE

5.3.2 Protein sidechains ⓘ

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	319/337 (95%)	311 (98%)	8 (2%)	42	66
1	B	311/337 (92%)	301 (97%)	10 (3%)	34	59
2	E	6/16 (38%)	6 (100%)	0	100	100
2	F	6/16 (38%)	6 (100%)	0	100	100
All	All	642/706 (91%)	624 (97%)	18 (3%)	38	62

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	11	LEU
1	A	96	ARG
1	A	108	VAL
1	A	168	VAL
1	A	204	CYS
1	A	212	ARG
1	A	245	ASP
1	A	269	ARG
1	B	35	PHE
1	B	105	LEU
1	B	143	GLN
1	B	157	VAL
1	B	159	ARG
1	B	181	ILE
1	B	212	ARG
1	B	287	LEU
1	B	297	SER
1	B	366	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	86	HIS
1	A	302	HIS
1	B	151	GLN
1	B	314	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 7 ligands modelled in this entry, 2 are monoatomic - leaving 5 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	$\# Z > 2$
5	MPD	B	1391	-	7,7,7	0.34	0	9,10,10	0.34	0
4	OGA	B	1390	3	9,9,9	2.64	2 (22%)	8,11,11	1.31	0
5	MPD	A	1392	-	7,7,7	0.30	0	9,10,10	0.29	0
6	PO4	A	1393	-	4,4,4	0.93	0	6,6,6	0.47	0
4	OGA	A	1391	3	9,9,9	2.66	2 (22%)	8,11,11	1.28	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
4	OGA	B	1390	3	-	5/8/9/9	-
4	OGA	A	1391	3	-	4/8/9/9	-
5	MPD	B	1391	-	-	2/5/5/5	-
5	MPD	A	1392	-	-	0/5/5/5	-

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1391	OGA	C2-N1	7.23	1.45	1.33
4	B	1390	OGA	C2-N1	7.19	1.45	1.33
4	B	1390	OGA	O1-C1	2.17	1.27	1.22
4	A	1391	OGA	O1-C1	2.13	1.27	1.22

There are no bond angle outliers.

There are no chirality outliers.

All (11) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	1391	OGA	O2-C1-C2-O2'
4	B	1390	OGA	O1-C1-C2-O2'
4	B	1390	OGA	O1-C1-C2-N1
4	B	1390	OGA	O2-C1-C2-O2'
4	A	1391	OGA	O1-C1-C2-O2'
4	A	1391	OGA	O1-C1-C2-N1
5	B	1391	MPD	O2-C2-C3-C4
4	B	1390	OGA	N1-C4-C5-O4
4	A	1391	OGA	C5-C4-N1-C2
5	B	1391	MPD	C2-C3-C4-O4
4	B	1390	OGA	N1-C4-C5-O3

There are no ring outliers.

2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	B	1391	MPD	1	0
5	A	1392	MPD	2	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, 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	388/406 (95%)	0.08	7 (1%) 67 59	46, 95, 142, 175	1 (0%)
1	B	385/406 (94%)	0.27	5 (1%) 75 69	44, 114, 152, 165	1 (0%)
2	E	8/20 (40%)	1.93	4 (50%) 0 0	111, 126, 131, 142	0
2	F	9/20 (45%)	0.71	0 100 100	113, 125, 145, 157	0
All	All	790/852 (92%)	0.20	16 (2%) 65 57	44, 104, 151, 175	2 (0%)

All (16) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	E	78	PRO	3.4
1	A	389	ALA	2.9
2	E	79	ALA	2.9
2	E	81	VAL	2.9
1	B	26	LEU	2.6
1	A	108	VAL	2.6
1	A	295	PRO	2.4
1	B	388	PRO	2.4
1	A	204	CYS	2.4
1	B	27	LEU	2.2
1	B	295	PRO	2.2
2	E	80	GLU	2.2
1	A	98	VAL	2.1
1	A	256	ASP	2.1
1	B	7	ILE	2.1
1	A	205	MET	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($\text{\AA}^2$)	Q<0.9
6	PO4	A	1393	5/5	0.73	0.10	163,163,163,163	0
5	MPD	A	1392	8/8	0.87	0.26	122,123,124,124	0
5	MPD	B	1391	8/8	0.87	0.37	120,120,121,121	0
4	OGA	A	1391	10/10	0.87	0.16	96,98,105,106	0
4	OGA	B	1390	10/10	0.88	0.14	119,121,128,128	0
3	MN	B	1389	1/1	0.99	0.05	96,96,96,96	0
3	MN	A	1390	1/1	1.00	0.02	82,82,82,82	0

6.5 Other polymers [i](#)

There are no such residues in this entry.