



# Full wwPDB X-ray Structure Validation Report

Feb 28, 2014 – 11:20 PM GMT

PDB ID : 3VRC  
Title : Crystal structure of cytochrome c' from Thermochromatium tepidum  
Authors : Hirano, Y.; Kimura, Y.; Suzuki, H.; Miki, K.; Wang, Z.-Y.  
Deposited on : 2012-04-09  
Resolution : 1.00 Å(reported)

This is a full wwPDB 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/ValidationPDFNotes.html>

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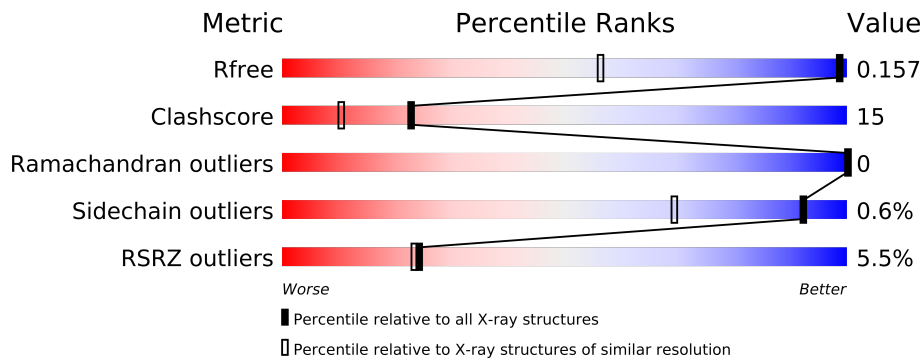
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : **FAILED**  
EDS : stable22639  
Percentile statistics : 21963  
Refmac : 5.8.0049  
CCP4 : 6.3.0 (Settle)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : stable22683

# 1 Overall quality at a glance

The reported resolution of this entry is 1.00 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))
$R_{free}$	66092	1007 (1.12-0.88)
Clashscore	79885	1028 (1.10-0.90)
Ramachandran outliers	78287	1056 (1.12-0.88)
Sidechain outliers	78261	1055 (1.12-0.88)
RSRZ outliers	66119	1007 (1.12-0.88)

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. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	131	
1	B	131	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
3	CD	B	202	-	X
5	PEG	A	207	-	X

## 2 Entry composition i

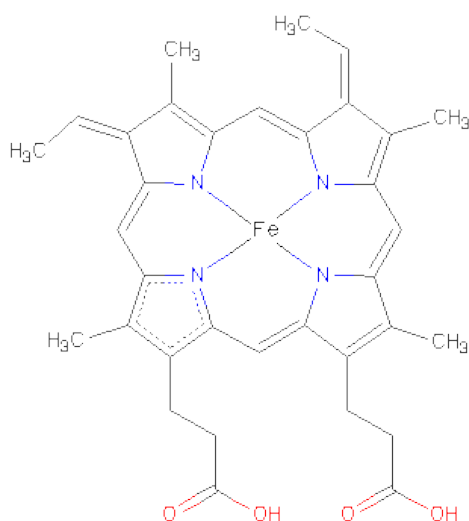
There are 7 unique types of molecules in this entry. The entry contains 2608 atoms, of which 0 are hydrogen and 0 are deuterium.

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 Cytochrome c'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	130	Total	C	N	O	S	0	9	0
			1001	620	181	194	6			
1	B	131	Total	C	N	O	S	0	7	0
			988	613	176	193	6			

- Molecule 2 is HEME C (three-letter code: HEC) (formula:  $C_{34}H_{34}FeN_4O_4$ ).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	Fe	N	O	0	1
			48	37	1	4	6		
2	B	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		

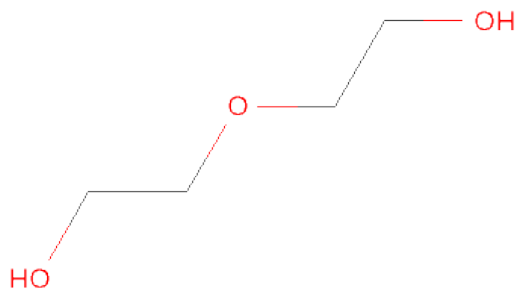
- Molecule 3 is CADMIUM ION (three-letter code: CD) (formula: Cd).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	B	4	Total	Cd	0	0
			4	4		
3	A	5	Total	Cd	0	0
			5	5		

- Molecule 4 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

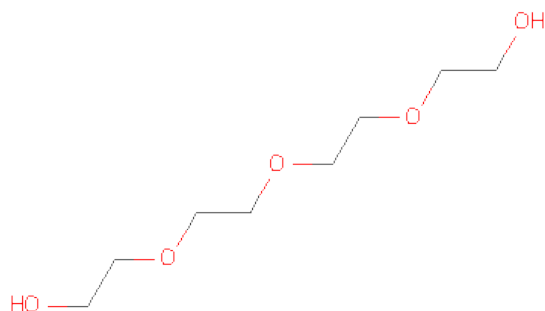
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total	Cl	0	0
			1	1		

- Molecule 5 is DI(HYDROXYETHYL)ETHER (three-letter code: PEG) (formula: C<sub>4</sub>H<sub>10</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			7	4	3		

- Molecule 6 is TETRAETHYLENE GLYCOL (three-letter code: PG4) (formula: C<sub>8</sub>H<sub>18</sub>O<sub>5</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			13	8	5		

- Molecule 7 is water.

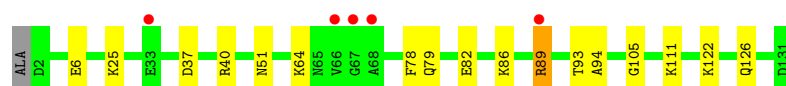
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	237	Total	O	0	8
			245	245		
7	B	242	Total	O	0	11
			253	253		

### 3 Residue-property plots

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.

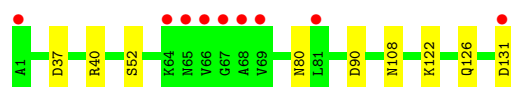
#### • Molecule 1: Cytochrome c'

Chain A: 



#### • Molecule 1: Cytochrome c'

Chain B: 



## 4 Data and refinement statistics

Xtriage (Phenix) failed to run properly - this section will therefore be incomplete.

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	41.31Å 57.19Å 54.23Å 90.00° 94.81° 90.00°	Depositor
Resolution (Å)	50.00 – 1.00 34.15 – 1.00	Depositor EDS
% Data completeness (in resolution range)	94.2 (50.00-1.00) 94.2 (34.15-1.00)	Depositor EDS
$R_{merge}$	0.04	Depositor
$R_{sym}$	(Not available)	Depositor
Refinement program	REFMAC 5.6.0117	Depositor
R, $R_{free}$	0.129 , 0.153 0.132 , 0.157	Depositor DCC
$R_{free}$ test set	6351 reflections (5.24%)	DCC
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.39 , 64.4	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.98	EDS
Total number of atoms	2608	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	16.0	wwPDB-VP

## 5 Model quality

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: HEC, PG4, CD, PEG, CL

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	0.92	0/1034	1.12	8/1392 (0.6%)
1	B	0.86	0/1021	0.88	1/1377 (0.1%)
All	All	0.89	0/2055	1.01	9/2769 (0.3%)

There are no bond length outliers.

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	89[A]	ARG	NE-CZ-NH1	8.98	124.79	120.30
1	A	89[B]	ARG	NE-CZ-NH1	8.98	124.79	120.30
1	A	40	ARG	NE-CZ-NH2	-8.94	115.83	120.30
1	A	40	ARG	NE-CZ-NH1	7.60	124.10	120.30
1	A	51[A]	ASN	CB-CA-C	5.85	122.09	110.40
1	A	51[B]	ASN	CB-CA-C	5.85	122.09	110.40
1	A	37	ASP	CB-CG-OD1	5.83	123.55	118.30
1	B	90	ASP	CB-CG-OD2	-5.30	113.53	118.30
1	A	78	PHE	CB-CG-CD1	-5.27	117.11	120.80

There are no chirality outliers.

There are no planarity outliers.

### 5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.



Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	1001	0	0	12	0
1	B	988	0	0	14	1
2	A	48	0	0	0	1
2	B	43	0	0	0	0
3	A	5	0	0	1	0
3	B	4	0	0	6	0
4	A	1	0	0	0	0
5	A	7	0	0	1	0
6	A	13	0	0	0	0
7	A	245	0	0	7	5
7	B	253	0	0	17	6
All	All	2608	0	0	31	7

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 15.

All (31) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
3:B:203:CD:CD	7:B:523:HOH:O	1.25	1.02
3:B:204:CD:CD	7:B:473:HOH:O	1.32	0.97
1:B:131:ASP:OD1	7:B:473:HOH:O	1.87	0.92
3:A:205:CD:CD	7:A:486:HOH:O	1.37	0.92
1:B:40[B]:ARG:NE	7:B:530:HOH:O	2.05	0.90
1:B:40[B]:ARG:CZ	7:B:530:HOH:O	2.22	0.87
3:B:203:CD:CD	7:B:542:HOH:O	1.46	0.85
1:A:122[A]:LYS:CE	1:A:126:GLN:NE2	2.46	0.78
1:A:79:GLN:NE2	7:A:452:HOH:O	2.18	0.76
1:B:108[B]:ASN:OD1	3:B:202:CD:CD	1.53	0.76
1:A:25[A]:LYS:NZ	7:A:323:HOH:O	2.22	0.73
3:B:202:CD:CD	7:B:518:HOH:O	1.56	0.73
1:B:40[B]:ARG:NH2	7:B:503:HOH:O	2.21	0.72
3:B:202:CD:CD	7:B:302:HOH:O	1.59	0.70
1:A:6[B]:GLU:OE2	7:A:359:HOH:O	2.12	0.68
1:B:37:ASP:OD2	7:B:523:HOH:O	2.13	0.66
1:B:108[B]:ASN:OD1	7:B:518:HOH:O	2.14	0.65
1:B:80:ASN:OD1	7:B:434:HOH:O	2.16	0.60
1:A:86:LYS:CE	1:A:89[B]:ARG:NH2	2.67	0.58
1:A:105:GLY:O	7:A:349:HOH:O	2.18	0.55
1:B:40[B]:ARG:NH1	7:B:530:HOH:O	2.38	0.54
1:A:93[B]:THR:CG2	1:A:94:ALA:N	2.72	0.52
1:B:108[B]:ASN:ND2	7:B:429[B]:HOH:O	2.42	0.51
1:A:111:LYS:NZ	7:A:420:HOH:O	2.46	0.49
1:A:82:GLU:OE2	5:A:207:PEG:C3	2.63	0.47

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Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:25[B]:LYS:NZ	1:B:52:SER:O	2.49	0.46
1:A:86:LYS:O	1:A:89[B]:ARG:CG	2.65	0.44
1:A:25[B]:LYS:NZ	7:A:350:HOH:O	2.53	0.42
1:B:122:LYS:NZ	7:B:502:HOH:O	2.53	0.41
1:B:40[B]:ARG:NH1	7:B:391:HOH:O	2.54	0.41
1:B:126:GLN:NE2	7:B:506:HOH:O	2.53	0.41

All (7) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:108[A]:ASN:ND2	7:A:471:HOH:O[1_455]	1.43	0.77
7:A:526:HOH:O	7:B:480:HOH:O[2_655]	1.89	0.31
7:A:348:HOH:O	7:B:524:HOH:O[1_655]	1.92	0.28
7:A:333:HOH:O	7:B:378[B]:HOH:O[2_655]	2.17	0.03
7:B:410:HOH:O	7:B:428:HOH:O[1_455]	2.17	0.03
2:A:200[B]:HEC:O2A	7:B:302:HOH:O[1_655]	2.18	0.02
7:A:329:HOH:O	7:B:315[A]:HOH:O[2_656]	2.19	0.01

## 5.3 Torsion angles

### 5.3.1 Protein backbone ⓘ

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	137/131 (105%)	133 (97%)	4 (3%)	0	100	100
1	B	136/131 (104%)	135 (99%)	1 (1%)	0	100	100
All	All	273/262 (104%)	268 (98%)	5 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 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	96/87 (110%)	95 (99%)	1 (1%)	85	55
1	B	94/87 (108%)	94 (100%)	0	100	100
All	All	190/174 (109%)	189 (100%)	1 (0%)	92	72

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	64	LYS

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 chains 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 ⓘ

Of 15 ligands modelled in this entry, 10 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
2	HEC	A	200[A]	-	4,4,50	2.49	1 (25%)	3,4,82	1.31	0
2	HEC	A	200[B]	-	4,4,50	2.32	1 (25%)	3,4,82	0.89	0
5	PEG	A	207	-	6,6,6	0.57	0	5,5,5	2.47	3 (60%)
6	PG4	A	208	-	12,12,12	0.78	0	11,11,11	1.02	0
2	HEC	B	201	1	50,50,50	2.33	12 (24%)	56,82,82	2.48	21 (37%)

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	HEC	A	200[A]	-	-	0/2/2/54	0/0/0/8
2	HEC	A	200[B]	-	-	0/2/2/54	0/0/0/8
5	PEG	A	207	-	-	0/4/4/4	0/0/0/0
6	PG4	A	208	-	-	0/10/10/10	0/0/0/0
2	HEC	B	201	1	-	0/10/54/54	0/0/8/8

All (14) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	201	HEC	C3B-CAB	8.20	1.52	1.35
2	B	201	HEC	C3C-CAC	7.68	1.51	1.35
2	B	201	HEC	C1C-C2C	5.09	1.46	1.40
2	A	200[A]	HEC	CAA-CBA	4.54	1.57	1.55
2	B	201	HEC	C1B-C2B	3.93	1.45	1.40
2	A	200[B]	HEC	CAA-CBA	3.76	1.56	1.55
2	B	201	HEC	FE-NA	3.59	2.07	1.92
2	B	201	HEC	C3C-C4C	3.19	1.45	1.41
2	B	201	HEC	FE-NB	2.94	2.05	1.92
2	B	201	HEC	FE-NC	2.84	2.04	1.92
2	B	201	HEC	C1D-C2D	2.74	1.43	1.40
2	B	201	HEC	C3B-C4B	2.68	1.45	1.41
2	B	201	HEC	C4D-C3D	2.43	1.47	1.43
2	B	201	HEC	FE-ND	2.16	2.01	1.92

All (24) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	201	HEC	CMC-C2C-C3C	6.39	132.78	125.72
2	B	201	HEC	C3B-C2B-C1B	-5.94	103.12	107.07

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	201	HEC	C3C-C2C-C1C	-5.30	103.55	107.07
2	B	201	HEC	C2D-C1D-ND	5.27	113.39	109.41
2	B	201	HEC	C4A-C3A-C2A	-5.26	103.55	106.89
2	B	201	HEC	C2B-C1B-NB	4.74	112.99	109.41
2	B	201	HEC	CBC-CAC-C3C	-4.36	116.16	128.44
2	B	201	HEC	CBB-CAB-C3B	-3.93	117.39	128.44
2	B	201	HEC	C2C-C1C-NC	3.70	112.20	109.41
5	A	207	PEG	O2-C2-C1	3.50	127.44	110.61
2	B	201	HEC	CMC-C2C-C1C	-3.22	123.66	128.62
2	B	201	HEC	C3A-C4A-NA	3.04	111.70	109.41
2	B	201	HEC	O2A-CGA-CBA	2.93	124.58	114.22
5	A	207	PEG	O2-C3-C4	2.73	123.72	110.61
2	B	201	HEC	CMB-C2B-C3B	2.70	128.70	125.72
5	A	207	PEG	C3-O2-C2	2.68	125.14	113.38
2	B	201	HEC	C2B-C1B-CHB	-2.48	121.29	126.00
2	B	201	HEC	CMA-C3A-C2A	2.42	129.51	124.94
2	B	201	HEC	C4D-ND-C1D	-2.41	103.59	106.76
2	B	201	HEC	O1A-CGA-CBA	-2.33	115.01	123.03
2	B	201	HEC	C4D-C3D-C2D	-2.25	104.59	106.92
2	B	201	HEC	C1A-CHA-C4D	-2.22	124.55	127.47
2	B	201	HEC	C3D-C4D-CHA	-2.16	121.91	126.00
2	B	201	HEC	CAA-CBA-CGA	-2.10	106.71	113.47

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 5.7 Other polymers ⓘ

There are no such residues in this entry.

## 5.8 Polymer linkage issues

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<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	130/131 (99%)	-0.01	5 (3%)	38 36	8, 12, 25, 42	0
1	B	131/131 (100%)	0.23	9 (6%)	17 17	8, 13, 40, 62	0
All	All	261/262 (99%)	0.11	14 (5%)	24 24	8, 12, 31, 62	0

All (14) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	66	VAL	8.3
1	A	68	ALA	7.2
1	B	1	ALA	4.8
1	B	81	LEU	4.0
1	B	64	LYS	4.0
1	B	67	GLY	3.9
1	A	67	GLY	3.6
1	B	69	VAL	3.5
1	B	68	ALA	2.8
1	B	131	ASP	2.8
1	B	65	ASN	2.6
1	A	66	VAL	2.4
1	A	89[A]	ARG	2.2
1	A	33	GLU	2.1

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

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

### 6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 6.4 Ligands ⓘ

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	RSR	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
3	CD	B	202	1/1	0.22	6.24	18,18,18,18	1
5	PEG	A	207	7/7	0.27	3.23	18,23,27,31	0
6	PG4	A	208	13/13	0.12	1.64	13,17,21,22	13
2	HEC	A	200[B]	5/43	0.08	0.63	10,11,14,14	5
2	HEC	A	200[A]	5/43	0.08	0.63	10,11,12,18	5
2	HEC	B	201	43/43	0.06	-0.14	8,9,13,14	0
4	CL	A	206	1/1	0.06	-0.72	18,18,18,18	0
3	CD	B	204	1/1	0.05	-0.81	45,45,45,45	1
3	CD	B	205	1/1	0.11	-0.82	29,29,29,29	1
3	CD	A	201	1/1	0.05	-1.18	12,12,12,12	1
3	CD	A	205	1/1	0.03	-1.37	17,17,17,17	1
3	CD	A	203	1/1	0.02	-1.77	13,13,13,13	1
3	CD	A	202	1/1	0.01	-2.20	13,13,13,13	1
3	CD	A	204	1/1	0.04	-3.00	17,17,17,17	1
3	CD	B	203	1/1	0.04	-4.16	20,20,20,20	1

## 6.5 Other polymers ⓘ

There are no such residues in this entry.