



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 28, 2014 – 09:01 AM GMT

PDB ID : 2DN3
Title : 1.25Å resolution crystal structure of human hemoglobin in the carbonmonoxy form
Authors : Park, S.-Y.; Yokoyama, T.; Shibayama, N.; Shiro, Y.; Tame, J.R.
Deposited on : 2006-04-25
Resolution : 1.25 Å(reported)

This is a full wwPDB validation report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

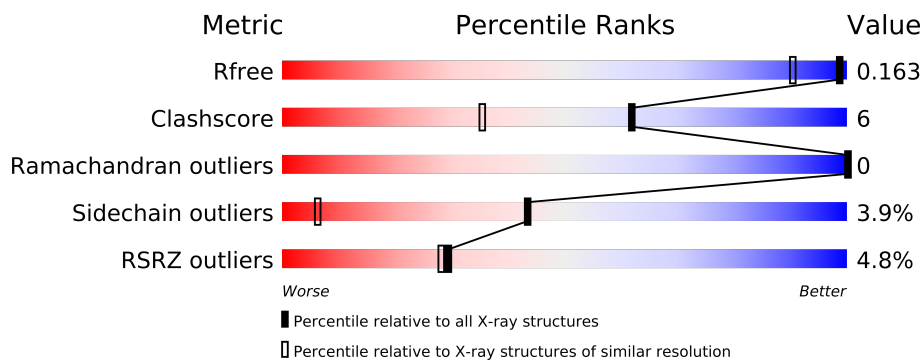
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.15 2013
Xtriage (Phenix) : dev-1323
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 1.25 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	1021 (1.30-1.22)
Clashscore	79885	1125 (1.30-1.22)
Ramachandran outliers	78287	1075 (1.30-1.22)
Sidechain outliers	78261	1073 (1.30-1.22)
RSRZ outliers	66119	1021 (1.30-1.22)

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 ≥ 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	141	
2	B	146	

2 Entry composition i

There are 5 unique types of molecules in this entry. The entry contains 2494 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.

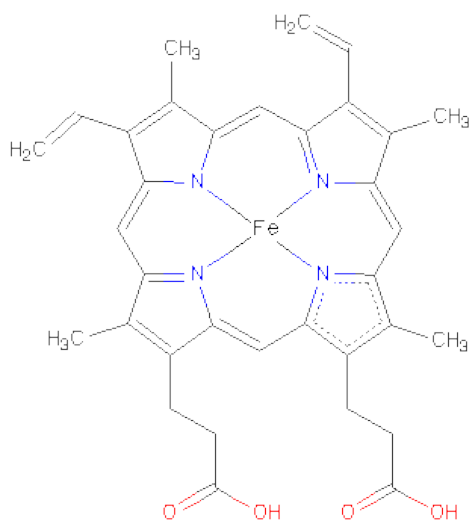
- Molecule 1 is a protein called Hemoglobin alpha subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	141	Total	C	N	O	S	0	0	0
			1069	685	187	194	3			

- Molecule 2 is a protein called Hemoglobin beta subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	146	Total	C	N	O	S	0	0	0
			1123	724	195	201	3			

- Molecule 3 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
3	B	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		

- Molecule 4 is CARBON MONOXIDE (three-letter code: CMO) (formula: CO).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			2	1	1		
4	B	1	Total	C	O	0	0
			2	1	1		

- Molecule 5 is water.

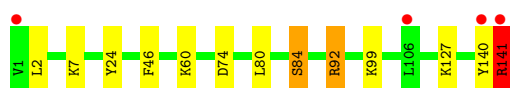
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	116	Total	O	0	0
			116	116		
5	B	96	Total	O	0	0
			96	96		

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 ($\text{RSRZ} > 2$). 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.

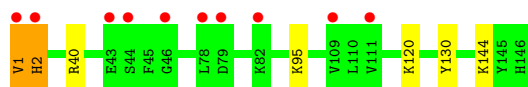
- Molecule 1: Hemoglobin alpha subunit

Chain A: 



- Molecule 2: Hemoglobin beta subunit

Chain B: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, α , β , γ	53.27Å 53.27Å 189.78Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 1.25 24.55 – 1.25	Depositor EDS
% Data completeness (in resolution range)	(Not available) (20.00-1.25) 100.0 (24.55-1.25)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.07 (at 1.25Å)	Xtriage
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.183 , (Not available) 0.161 , 0.163	Depositor DCC
R_{free} test set	3837 reflections (5.26%)	DCC
Wilson B-factor (Å ²)	16.7	Xtriage
Anisotropy	0.034	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.39 , 41.6	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Outliers	0 of 76774 reflections	Xtriage
F_o, F_c correlation	0.97	EDS
Total number of atoms	2494	wwPDB-VP
Average B, all atoms (Å ²)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.40% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

5 Model quality ⓘ

5.1 Standard geometry ⓘ

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

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	1.43	1/1097 (0.1%)	1.11	5/1491 (0.3%)
2	B	0.58	0/1153	1.11	4/1566 (0.3%)
All	All	1.08	1/2250 (0.0%)	1.11	9/3057 (0.3%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	141	ARG	C-OXT	43.29	2.05	1.23

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	40	ARG	CD-NE-CZ	8.88	136.03	123.60
1	A	140	TYR	CB-CG-CD1	-7.86	116.28	121.00
2	B	1	VAL	C-N-CA	6.55	138.07	121.70
1	A	92	ARG	NE-CZ-NH2	-6.21	117.19	120.30
1	A	24	TYR	CB-CG-CD1	-5.84	117.50	121.00
1	A	46	PHE	CB-CG-CD1	-5.84	116.71	120.80
2	B	130	TYR	CB-CG-CD1	-5.63	117.62	121.00
1	A	141	ARG	NE-CZ-NH1	-5.50	117.55	120.30
2	B	2	HIS	CA-C-N	5.04	128.29	117.20

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	1069	0	0	7	0
2	B	1123	0	0	0	0
3	A	43	0	0	6	0
3	B	43	0	0	0	0
4	A	2	0	0	0	0
4	B	2	0	0	0	0
5	A	116	0	0	3	0
5	B	96	0	0	0	0
All	All	2494	0	0	13	0

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 6.

All (13) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
3:A:142:HEM:CBD	3:A:142:HEM:CGD	1.76	1.60
3:A:142:HEM:CGA	3:A:142:HEM:CBA	1.96	1.40
1:A:141:ARG:OXT	1:A:141:ARG:C	2.05	0.93
3:A:142:HEM:CAD	3:A:142:HEM:CGD	2.59	0.79
3:A:142:HEM:O2A	3:A:142:HEM:CBA	2.37	0.72
3:A:142:HEM:CBD	3:A:142:HEM:O2D	2.47	0.61
3:A:142:HEM:CAA	3:A:142:HEM:CGA	2.78	0.54
1:A:141:ARG:OXT	1:A:141:ARG:O	2.29	0.50
1:A:80:LEU:O	1:A:84:SER:OG	2.30	0.50
1:A:7:LYS:NZ	1:A:74:ASP:OD2	2.49	0.46
1:A:60:LYS:NZ	5:A:247:HOH:O	2.49	0.45
1:A:127:LYS:NZ	5:A:223:HOH:O	2.50	0.45
1:A:99:LYS:NZ	5:A:240:HOH:O	2.50	0.45

There are no symmetry-related clashes.

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	139/141 (99%)	139 (100%)	0	0	100	100
2	B	144/146 (99%)	141 (98%)	3 (2%)	0	100	100
All	All	283/287 (99%)	280 (99%)	3 (1%)	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	113/113 (100%)	109 (96%)	4 (4%)	48	8
2	B	118/118 (100%)	113 (96%)	5 (4%)	40	5
All	All	231/231 (100%)	222 (96%)	9 (4%)	43	6

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2	LEU
1	A	84	SER
1	A	92	ARG
1	A	141	ARG
2	B	1	VAL
2	B	2	HIS
2	B	95	LYS
2	B	120	LYS
2	B	144	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 ⓘ

4 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	$\# Z > 2$
3	HEM	A	142	1,4	49,50,50	5.91	26 (53%)	46,82,82	3.11	18 (39%)
4	CMO	A	143	3	0,1,1	0.00	-	0,0,0	0.00	-
3	HEM	B	147	2,4	49,50,50	5.79	25 (51%)	46,82,82	2.62	19 (41%)
4	CMO	B	148	3	0,1,1	0.00	-	0,0,0	0.00	-

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
3	HEM	A	142	1,4	-	0/14/114/114	0/0/8/8
4	CMO	A	143	3	-	0/0/0/0	0/0/0/0
3	HEM	B	147	2,4	-	0/14/114/114	0/0/8/8
4	CMO	B	148	3	-	0/0/0/0	0/0/0/0

All (51) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	147	HEM	C2D-C1D	31.06	1.52	1.44
3	A	142	HEM	C3D-C4D	26.17	1.51	1.44

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	142	HEM	CBA-CGA	17.99	1.96	1.50
3	A	142	HEM	C2D-C1D	15.54	1.48	1.44
3	B	147	HEM	C2B-C1B	13.09	1.47	1.44
3	A	142	HEM	CBD-CGD	10.03	1.76	1.50
3	B	147	HEM	C4A-C3A	7.10	1.49	1.40
3	B	147	HEM	C4A-NA	6.44	1.49	1.36
3	B	147	HEM	CBA-CGA	6.43	1.67	1.50
3	A	142	HEM	O2D-CGD	6.37	1.53	1.30
3	A	142	HEM	O2A-CGA	6.28	1.53	1.30
3	A	142	HEM	C3C-C2C	-6.24	1.32	1.43
3	A	142	HEM	O1D-CGD	-6.20	1.00	1.22
3	B	147	HEM	C1A-C2A	6.19	1.54	1.43
3	B	147	HEM	C3B-C2B	-5.86	1.33	1.43
3	B	147	HEM	CHB-C1B	5.58	1.43	1.35
3	A	142	HEM	CAA-C2A	-5.56	1.42	1.52
3	B	147	HEM	C3D-C2D	-5.12	1.34	1.43
3	B	147	HEM	C3B-CAB	4.92	1.55	1.40
3	B	147	HEM	C3C-C2C	-4.69	1.35	1.43
3	B	147	HEM	O1A-CGA	4.15	1.37	1.22
3	A	142	HEM	CHD-C4C	4.13	1.44	1.36
3	B	147	HEM	CMA-C3A	4.12	1.60	1.51
3	B	147	HEM	CHA-C4D	3.97	1.41	1.35
3	B	147	HEM	C3C-CAC	3.84	1.52	1.40
3	B	147	HEM	O2A-CGA	-3.82	1.16	1.30
3	A	142	HEM	C2B-C1B	-3.77	1.43	1.44
3	B	147	HEM	C2A-C3A	-3.44	1.27	1.37
3	A	142	HEM	FE-ND	3.31	2.09	1.97
3	B	147	HEM	C1C-NC	3.30	1.42	1.38
3	B	147	HEM	C1A-CHA	3.30	1.48	1.39
3	A	142	HEM	CMC-C2C	3.19	1.57	1.47
3	B	147	HEM	CBB-CAB	-2.97	1.11	1.28
3	A	142	HEM	C3D-C2D	-2.97	1.38	1.43
3	B	147	HEM	C4C-NC	2.95	1.42	1.38
3	B	147	HEM	C2C-C1C	2.75	1.51	1.43
3	B	147	HEM	CAA-CBA	-2.69	1.38	1.53
3	A	142	HEM	FE-NA	2.61	2.03	1.92
3	B	147	HEM	CAD-C3D	-2.58	1.42	1.51
3	A	142	HEM	C3B-C4B	2.57	1.47	1.44
3	A	142	HEM	C3B-CAB	2.56	1.48	1.40
3	A	142	HEM	C4A-C3A	-2.54	1.37	1.40
3	A	142	HEM	CHC-C4B	2.46	1.45	1.39
3	A	142	HEM	C4A-NA	2.45	1.41	1.36

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	142	HEM	C1A-NA	2.35	1.41	1.36
3	A	142	HEM	C3B-C2B	-2.17	1.40	1.43
3	A	142	HEM	CHA-C4D	2.16	1.38	1.35
3	A	142	HEM	C1A-CHA	-2.13	1.34	1.39
3	A	142	HEM	CHD-C1D	-2.06	1.34	1.39
3	A	142	HEM	C1C-NC	-2.03	1.35	1.38
3	B	147	HEM	CHD-C1D	-2.00	1.34	1.39

All (37) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	142	HEM	O2A-CGA-O1A	9.27	146.88	123.30
3	A	142	HEM	O2A-CGA-CBA	-8.46	84.31	114.22
3	A	142	HEM	C4D-ND-C1D	7.55	112.89	105.16
3	A	142	HEM	CHD-C1D-ND	6.48	129.97	124.58
3	B	147	HEM	CMA-C3A-C4A	-5.99	119.41	128.62
3	B	147	HEM	C4C-NC-C1C	5.87	111.64	105.53
3	A	142	HEM	C2D-C1D-ND	-5.70	106.20	112.93
3	B	147	HEM	C1A-CHA-C4D	-5.57	120.14	127.47
3	B	147	HEM	O1A-CGA-CBA	-5.56	103.89	123.03
3	A	142	HEM	O2D-CGD-CBD	-4.78	97.31	114.22
3	B	147	HEM	C3B-C4B-NB	-4.63	110.69	114.00
3	B	147	HEM	C2D-C1D-ND	-4.38	107.76	112.93
3	B	147	HEM	C4A-CHB-C1B	-4.35	121.74	127.47
3	A	142	HEM	C3B-C4B-NB	-3.96	111.17	114.00
3	A	142	HEM	CHB-C4A-NA	-3.66	118.47	124.58
3	B	147	HEM	CMC-C2C-C3C	3.55	134.53	126.16
3	B	147	HEM	C4A-C3A-C2A	3.38	109.35	107.00
3	A	142	HEM	C3A-C4A-NA	3.34	111.93	109.41
3	B	147	HEM	O2A-CGA-CBA	3.29	125.85	114.22
3	A	142	HEM	CHA-C4D-ND	3.10	128.56	124.31
3	B	147	HEM	O2D-CGD-CBD	2.99	124.79	114.22
3	A	142	HEM	C4A-CHB-C1B	2.96	131.37	127.47
3	A	142	HEM	CBD-CAD-C3D	-2.93	107.97	114.37
3	B	147	HEM	CMB-C2B-C3B	2.85	132.88	126.16
3	B	147	HEM	CMA-C3A-C2A	2.85	130.32	124.94
3	B	147	HEM	C3A-C4A-NA	-2.65	107.41	109.41
3	A	142	HEM	C1B-NB-C4B	2.60	107.82	105.16
3	A	142	HEM	CMA-C3A-C4A	-2.43	124.89	128.62
3	A	142	HEM	C4A-NA-C1A	-2.39	103.62	106.76
3	B	147	HEM	CHD-C1D-ND	2.28	126.48	124.58
3	A	142	HEM	CAD-CBD-CGD	-2.25	106.47	113.48

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	142	HEM	CMD-C2D-C3D	2.23	130.64	125.60
3	A	142	HEM	O2D-CGD-O1D	-2.20	117.69	123.30
3	B	147	HEM	CHC-C1C-NC	2.15	126.60	124.73
3	B	147	HEM	CAA-C2A-C1A	-2.13	119.07	125.50
3	B	147	HEM	CAA-CBA-CGA	-2.10	106.71	113.47
3	B	147	HEM	O1D-CGD-CBD	-2.08	115.87	123.03

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, 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	141/141 (100%)	0.39	4 (2%)	50	51	13, 19, 28, 53	0
2	B	146/146 (100%)	0.56	10 (6%)	17	15	15, 20, 33, 56	0
All	All	287/287 (100%)	0.47	14 (4%)	29	27	13, 19, 32, 56	0

All (14) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	1	VAL	4.4
2	B	2	HIS	3.9
1	A	1	VAL	3.8
2	B	43	GLU	3.6
1	A	141	ARG	3.4
2	B	79	ASP	2.9
2	B	109	VAL	2.9
2	B	111	VAL	2.8
2	B	46	GLY	2.5
2	B	82	LYS	2.4
2	B	78	LEU	2.3
1	A	106	LEU	2.2
2	B	44	SER	2.2
1	A	140	TYR	2.2

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, 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	RSR	LLDF	B-factors(\AA^2)	Q<0.9
3	HEM	A	142	43/43	0.10	0.63	12,14,30,39	0
4	CMO	A	143	2/2	0.10	-0.24	14,14,14,14	0
3	HEM	B	147	43/43	0.06	-0.83	15,17,25,34	0
4	CMO	B	148	2/2	0.07	-0.95	14,14,14,17	0

6.5 Other polymers

There are no such residues in this entry.