



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 7, 2018 – 03:46 pm GMT

PDB ID : 1MBO  
Title : Structure and refinement of oxymyoglobin at 1.6 angstroms resolution  
Authors : Phillips, S.E.V.  
Deposited on : 1981-08-27  
Resolution : 1.60 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

<https://www.wwpdb.org/validation/2017/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 : 1.7.3 (157068), CSD as539be (2018)  
Xtriage (Phenix) : 1.13  
EDS : trunk30967  
Percentile statistics : (not set)  
Refmac : 5.8.0158  
CCP4 : 7.0 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk30967

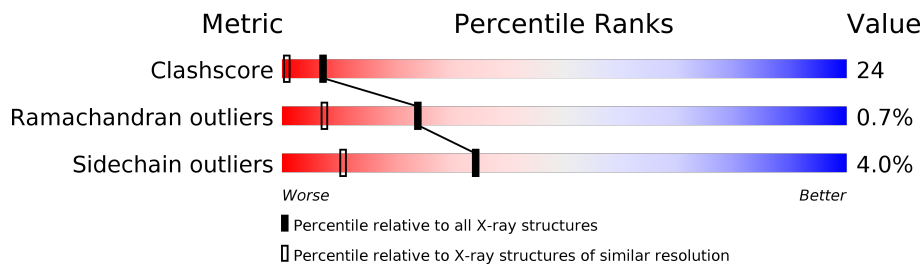
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.60 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))
Clashscore	122126	3202 (1.60-1.60)
Ramachandran outliers	120053	3117 (1.60-1.60)
Sidechain outliers	120020	3116 (1.60-1.60)

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  $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	153	

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 1611 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 MYOGLOBIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	153	1227	791	217	217	2	0	4	0

- Molecule 2 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).



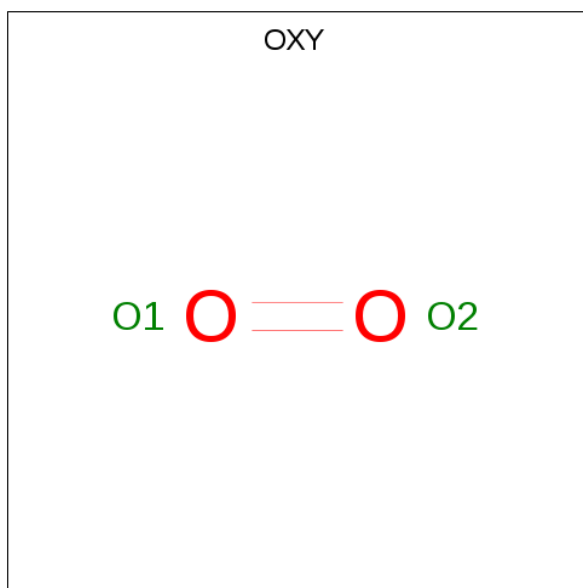
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	O	S		
2	A	1	5	4	1	0	0

- Molecule 3 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: C<sub>34</sub>H<sub>32</sub>FeN<sub>4</sub>O<sub>4</sub>).



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

- Molecule 4 is OXYGEN MOLECULE (three-letter code: OXY) (formula: O<sub>2</sub>).



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

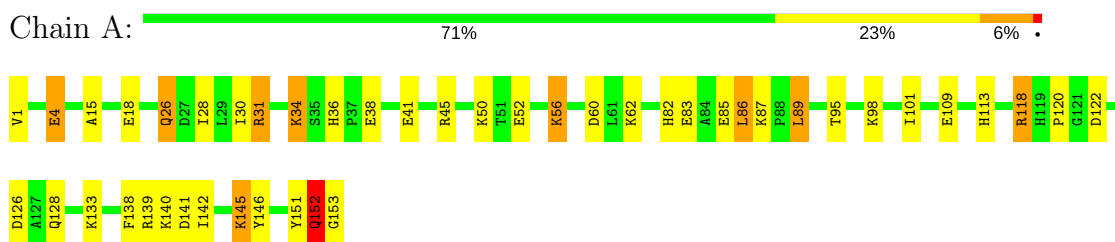
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	334	Total 334	O 334	0	0

### 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. 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. 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: MYOGLOBIN



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	64.53Å 31.05Å 34.93Å 90.00° 105.79° 90.00°	Depositor
Resolution (Å)	(Not available) – 1.60 17.46 – 1.50	Depositor EDS
% Data completeness (in resolution range)	(Not available) ((Not available)-1.60) 84.3 (17.46-1.50)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.31 (at 1.50Å)	Xtriage
Refinement program	CONSTRAINED RECIPROCAL-SPACE LEAST-SQUARES	Depositor
R, $R_{free}$	(Not available) , (Not available) 0.187 , (Not available)	Depositor DCO
$R_{free}$ test set	No test flags present.	wwPDB
Wilson B-factor (Å <sup>2</sup> )	11.6	Xtriage
Anisotropy	0.199	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 47.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	0.039 for -h-l,-k,l	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	1611	wwPDB
Average B, all atoms (Å <sup>2</sup> )	21.0	wwPDB

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 11.80% 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 i

### 5.1 Standard geometry i

Bond lengths and bond angles in the following residue types are not validated in this section: HEM, OXY, SO4

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	1.15	0/1277	1.55	17/1715 (1.0%)

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	6

There are no bond length outliers.

All (17) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	118	ARG	NE-CZ-NH2	-15.74	112.43	120.30
1	A	146	TYR	CB-CG-CD2	-9.83	115.10	121.00
1	A	118	ARG	NE-CZ-NH1	8.94	124.77	120.30
1	A	151	TYR	CB-CG-CD1	-8.52	115.89	121.00
1	A	146	TYR	CB-CG-CD1	7.83	125.70	121.00
1	A	126	ASP	CB-CG-OD2	7.45	125.01	118.30
1	A	45	ARG	N-CA-CB	-7.05	97.91	110.60
1	A	138	PHE	CB-CG-CD2	-6.74	116.08	120.80
1	A	31	ARG	NE-CZ-NH1	-6.15	117.22	120.30
1	A	60	ASP	CB-CG-OD1	-6.13	112.78	118.30
1	A	126	ASP	CB-CG-OD1	-5.92	112.97	118.30
1	A	146	TYR	CA-CB-CG	5.69	124.21	113.40
1	A	139	ARG	NE-CZ-NH2	5.44	123.02	120.30
1	A	28	ILE	CG1-CB-CG2	5.39	123.27	111.40
1	A	133	LYS	CB-CG-CD	-5.38	97.61	111.60
1	A	4	GLU	CG-CD-OE2	-5.33	107.65	118.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	142	ILE	CA-CB-CG1	5.26	121.00	111.00

There are no chirality outliers.

All (6) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	118	ARG	Sidechain
1	A	152	GLN	Mainchain
1	A	26	GLN	Sidechain
1	A	36	HIS	Mainchain
1	A	4	GLU	Sidechain
1	A	52	GLU	Sidechain

## 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	1227	0	1257	59	4
2	A	5	0	0	0	0
3	A	43	0	30	3	0
4	A	2	0	0	0	0
5	A	334	0	0	36	34
All	All	1611	0	1287	62	34

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 24.

All (62) 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:128[B]:GLN:CD	1:A:128[B]:GLN:CG	1.81	1.46
1:A:145:LYS:HG3	5:A:479:HOH:O	1.40	1.18
1:A:140:LYS:HE3	5:A:461:HOH:O	1.53	1.07
1:A:87:LYS:HE3	5:A:474:HOH:O	1.54	1.06
1:A:153:GLY:O	5:A:361:HOH:O	1.73	1.06

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:26:GLN:CD	5:A:323:HOH:O	1.96	1.04
1:A:18:GLU:HB2	5:A:324:HOH:O	0.82	0.99
1:A:152:GLN:O	5:A:463:HOH:O	1.87	0.93
1:A:113:HIS:NE2	5:A:462:HOH:O	2.03	0.90
1:A:83:GLU:OE2	5:A:246:HOH:O	1.95	0.85
1:A:109:GLU:CG	5:A:487:HOH:O	2.25	0.85
1:A:128[B]:GLN:CG	5:A:224:HOH:O	2.23	0.85
1:A:122:ASP:CG	5:A:343:HOH:O	2.19	0.80
1:A:153:GLY:O	5:A:360:HOH:O	1.99	0.79
3:A:155:HEM:O1D	5:A:469:HOH:O	2.01	0.78
1:A:109:GLU:CD	5:A:487:HOH:O	2.22	0.77
1:A:1:VAL:CG1	5:A:475:HOH:O	2.34	0.76
1:A:1:VAL:HG13	5:A:475:HOH:O	1.85	0.74
1:A:31:ARG:NH1	5:A:462:HOH:O	2.20	0.73
1:A:15:ALA:O	5:A:324:HOH:O	2.05	0.73
3:A:155:HEM:CGD	5:A:469:HOH:O	2.39	0.71
1:A:128[B]:GLN:OE1	1:A:128[B]:GLN:CG	2.39	0.70
1:A:109:GLU:HG3	5:A:348:HOH:O	1.93	0.68
1:A:120:PRO:O	5:A:459:HOH:O	2.14	0.66
1:A:50:LYS:HE3	5:A:248:HOH:O	1.96	0.65
1:A:122:ASP:OD1	5:A:343:HOH:O	2.13	0.65
1:A:101:ILE:H	1:A:153:GLY:HA2	1.62	0.64
1:A:86[B]:LEU:CD2	1:A:86[B]:LEU:CD1	2.73	0.64
1:A:26:GLN:NE2	5:A:299:HOH:O	2.33	0.60
1:A:101:ILE:HG12	1:A:153:GLY:HA2	1.83	0.59
1:A:18:GLU:CB	5:A:324:HOH:O	1.67	0.57
1:A:83:GLU:HG3	5:A:246:HOH:O	2.07	0.54
1:A:128[B]:GLN:NE2	1:A:128[B]:GLN:CG	2.67	0.53
1:A:83:GLU:CD	1:A:83:GLU:H	2.13	0.53
1:A:113:HIS:CE1	5:A:462:HOH:O	2.54	0.51
1:A:109:GLU:HG3	5:A:487:HOH:O	1.99	0.49
1:A:26:GLN:NE2	5:A:323:HOH:O	2.34	0.49
1:A:18:GLU:CA	5:A:324:HOH:O	2.32	0.47
1:A:18:GLU:N	5:A:324:HOH:O	2.47	0.46
1:A:82:HIS:HA	1:A:85:GLU:OE1	2.15	0.46
1:A:145:LYS:HE3	5:A:358:HOH:O	2.16	0.45
3:A:155:HEM:HMC2	3:A:155:HEM:HBC2	1.99	0.44
1:A:34:LYS:HB3	1:A:34:LYS:HE2	1.76	0.43
1:A:141:ASP:O	1:A:145:LYS:HE2	2.19	0.43
1:A:109:GLU:HB2	5:A:349:HOH:O	2.19	0.42
1:A:95:THR:O	1:A:98:LYS:HE3	2.19	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:34:LYS:HE3	5:A:285:HOH:O	2.19	0.42
1:A:82:HIS:CD2	1:A:86[B]:LEU:HD22	2.55	0.42
1:A:101:ILE:CG1	1:A:153:GLY:HA2	2.48	0.41
1:A:26:GLN:OE1	1:A:62:LYS:HD2	2.19	0.41
1:A:83:GLU:HB3	5:A:369:HOH:O	2.19	0.41
1:A:128[B]:GLN:NE2	1:A:128[B]:GLN:HB2	2.34	0.41
1:A:30:ILE:CD1	1:A:56:LYS:HG2	2.51	0.41
1:A:82:HIS:CD2	1:A:86[A]:LEU:HD13	2.56	0.40

All (34) 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	Interatomic distance (Å)	Clash overlap (Å)
5:A:404:HOH:O	5:A:407:HOH:O[1_554]	0.23	1.97
5:A:193:HOH:O	5:A:292:HOH:O[2_645]	0.56	1.64
5:A:433:HOH:O	5:A:478:HOH:O[2_546]	0.61	1.59
5:A:405:HOH:O	5:A:446:HOH:O[2_556]	0.83	1.37
5:A:456:HOH:O	5:A:473:HOH:O[1_546]	1.00	1.20
5:A:223:HOH:O	5:A:460:HOH:O[1_565]	1.13	1.07
5:A:170:HOH:O	5:A:476:HOH:O[2_556]	1.24	0.96
5:A:219:HOH:O	5:A:398:HOH:O[1_554]	1.42	0.78
5:A:208:HOH:O	5:A:389:HOH:O[2_646]	1.48	0.72
5:A:180:HOH:O	5:A:464:HOH:O[2_556]	1.52	0.68
5:A:210:HOH:O	5:A:488:HOH:O[1_556]	1.58	0.62
5:A:169:HOH:O	5:A:456:HOH:O[1_564]	1.59	0.61
5:A:328:HOH:O	5:A:442:HOH:O[2_655]	1.59	0.61
5:A:209:HOH:O	5:A:400:HOH:O[2_646]	1.60	0.60
5:A:281:HOH:O	5:A:485:HOH:O[2_546]	1.61	0.59
5:A:319:HOH:O	5:A:352:HOH:O[1_554]	1.62	0.58
5:A:170:HOH:O	5:A:464:HOH:O[2_556]	1.63	0.57
1:A:38:GLU:CB	5:A:486:HOH:O[1_554]	1.75	0.45
5:A:220:HOH:O	5:A:379:HOH:O[1_554]	1.78	0.42
5:A:268:HOH:O	5:A:434:HOH:O[2_656]	1.81	0.39
1:A:41:GLU:OE1	5:A:355:HOH:O[1_554]	1.83	0.37
5:A:267:HOH:O	5:A:431:HOH:O[2_656]	1.84	0.36
5:A:319:HOH:O	5:A:422:HOH:O[1_554]	1.97	0.23
5:A:254:HOH:O	5:A:387:HOH:O[2_545]	1.97	0.23
5:A:180:HOH:O	5:A:416:HOH:O[2_556]	1.99	0.21
5:A:338:HOH:O	5:A:364:HOH:O[1_545]	1.99	0.21
5:A:219:HOH:O	5:A:357:HOH:O[1_554]	2.03	0.17

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
5:A:327:HOH:O	5:A:438:HOH:O[1_554]	2.05	0.15
5:A:219:HOH:O	5:A:388:HOH:O[1_554]	2.06	0.14
5:A:366:HOH:O	5:A:440:HOH:O[2_656]	2.13	0.07
5:A:161:HOH:O	5:A:456:HOH:O[1_564]	2.14	0.06
1:A:38:GLU:CA	5:A:486:HOH:O[1_554]	2.14	0.06
1:A:38:GLU:O	5:A:486:HOH:O[1_554]	2.19	0.01
5:A:252:HOH:O	5:A:389:HOH:O[2_646]	2.19	0.01

## 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	155/153 (101%)	151 (97%)	3 (2%)	1 (1%)	27 9

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	152	GLN

### 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	129/125 (103%)	122 (95%)	7 (5%)	24 6

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	34	LYS
1	A	56	LYS
1	A	86[A]	LEU
1	A	86[B]	LEU
1	A	89[A]	LEU
1	A	89[B]	LEU
1	A	145	LYS

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	81	HIS
1	A	91	GLN

### 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](#)

3 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	SO4	A	154	-	4,4,4	0.28	0	6,6,6	0.33	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
3	HEM	A	155	1,4	27,50,50	2.29	9 (33%)	17,82,82	2.30	7 (41%)
4	OXY	A	555	3	1,1,1	0.13	0	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
2	SO4	A	154	-	-	0/0/0/0	0/0/0/0
3	HEM	A	155	1,4	-	0/6/54/54	0/0/8/8
4	OXY	A	555	3	-	0/0/0/0	0/0/0/0

All (9) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	155	HEM	C4A-CHB	-3.24	1.31	1.40
3	A	155	HEM	C1D-ND	-2.28	1.31	1.36
3	A	155	HEM	CBB-CAB	2.04	1.42	1.29
3	A	155	HEM	C3C-C2C	2.09	1.43	1.40
3	A	155	HEM	CBC-CAC	2.48	1.45	1.29
3	A	155	HEM	C3C-CAC	3.31	1.54	1.47
3	A	155	HEM	C4A-NA	3.33	1.43	1.36
3	A	155	HEM	C4B-NB	4.19	1.44	1.36
3	A	155	HEM	C1A-NA	7.09	1.50	1.36

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	155	HEM	CMD-C2D-C1D	-4.06	122.23	128.46
3	A	155	HEM	C4C-C3C-C2C	-3.80	104.24	106.90
3	A	155	HEM	CBD-CAD-C3D	-2.35	107.98	112.47
3	A	155	HEM	C4A-C3A-C2A	2.40	108.67	107.00
3	A	155	HEM	C3B-C4B-NB	3.25	113.41	109.21
3	A	155	HEM	CMC-C2C-C3C	3.54	131.34	124.88
3	A	155	HEM	CMD-C2D-C3D	3.62	131.76	124.94

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	155	HEM	3	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](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

### 6.3 Carbohydrates [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

### 6.4 Ligands [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.