



# Full wwPDB X-ray Structure Validation Report ⓘ

Jan 31, 2016 – 06:21 PM GMT

PDB ID : 1AES  
Title : SPECIFICITY OF LIGAND BINDING TO A BURIED POLAR CAVITY AT  
THE ACTIVE SITE OF CYTOCHROME C PEROXIDASE (IMIDAZOLE)  
Authors : Musah, R.A.; Jensen, G.M.; Fitzgerald, M.M.; Mcree, D.E.; Goodin, D.B.  
Deposited on : 1997-02-25  
Resolution : 2.10 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 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
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) : trunk26865

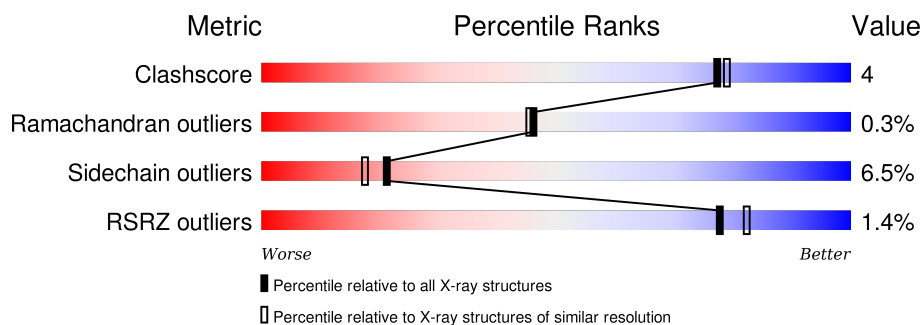
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.10 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	102246	4460 (2.10-2.10)
Ramachandran outliers	100387	4413 (2.10-2.10)
Sidechain outliers	100360	4414 (2.10-2.10)
RSRZ outliers	91569	3948 (2.10-2.10)

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	294	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
3	IMD	A	296	-	-	-	X

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 2941 atoms, of which 505 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 CYTOCHROME C PEROXIDASE.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	291	Total	C	H	N	O	S	0	0	0
			2841	1492	503	388	452	6			

There are 4 discrepancies between the modelled and reference sequences:

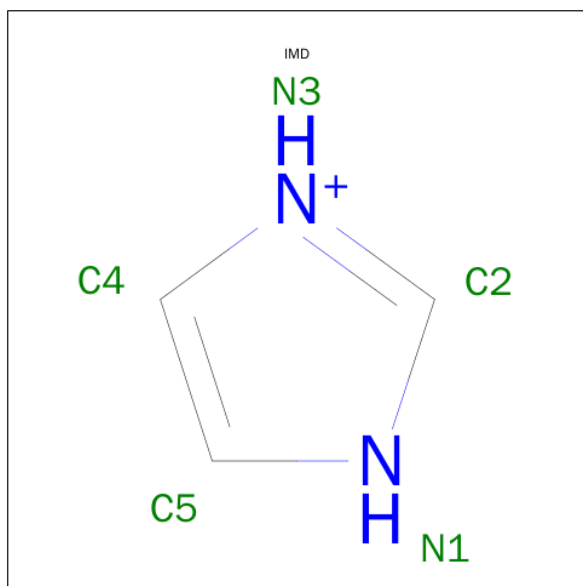
Chain	Residue	Modelled	Actual	Comment	Reference
A	53	ILE	THR	STRAIN	UNP P00431
A	152	GLY	ASP	STRAIN	UNP P00431
A	191	GLY	TRP	ENGINEERED	UNP P00431
A	272	ASP	ASN	CONFLICT	UNP P00431

- Molecule 2 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula:  $C_{34}H_{32}FeN_4O_4$ ).



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

- Molecule 3 is IMIDAZOLE (three-letter code: IMD) (formula:  $C_3H_5N_2$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	H	N	0	0
			7	3	2	2		

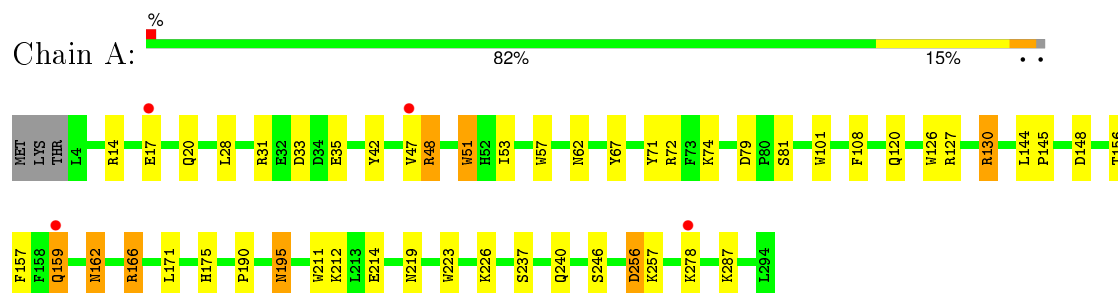
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	50	Total	O	0	0
			50	50		

### 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: CYTOCHROME C PEROXIDASE



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	108.00Å 77.30Å 51.80Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	7.00 – 2.10 33.65 – 2.12	Depositor EDS
% Data completeness (in resolution range)	79.0 (7.00-2.10) 63.1 (33.65-2.12)	Depositor EDS
$R_{merge}$	0.09	Depositor
$R_{sym}$	0.08	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.36 (at 2.12Å)	Xtriage
Refinement program	XTALVIEW	Depositor
R, $R_{free}$	(Not available) , (Not available) 0.193 , (Not available)	Depositor DCC
$R_{free}$ test set	No test flags present.	DCC
Wilson B-factor (Å <sup>2</sup> )	19.9	Xtriage
Anisotropy	0.175	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 53.0	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.46$ , $\langle L^2 \rangle = 0.29$	Xtriage
Outliers	0 of 16033 reflections	Xtriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	2941	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	14.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.75% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: HEM, IMD

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	0.83	0/2402	1.56	38/3250 (1.2%)

There are no bond length outliers.

All (38) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	48	ARG	NE-CZ-NH1	9.68	125.14	120.30
1	A	223	TRP	CD1-CG-CD2	8.39	113.01	106.30
1	A	57	TRP	CD1-CG-CD2	8.35	112.98	106.30
1	A	101	TRP	CD1-CG-CD2	7.95	112.66	106.30
1	A	126	TRP	CD1-CG-CD2	7.79	112.53	106.30
1	A	57	TRP	CE2-CD2-CG	-7.70	101.14	107.30
1	A	162	ASN	CA-C-N	-7.67	100.33	117.20
1	A	51	TRP	CD1-CG-CD2	7.64	112.41	106.30
1	A	101	TRP	CE2-CD2-CG	-7.19	101.55	107.30
1	A	223	TRP	CE2-CD2-CG	-7.18	101.56	107.30
1	A	51	TRP	CE2-CD2-CG	-7.07	101.64	107.30
1	A	71	TYR	CB-CG-CD2	-6.87	116.88	121.00
1	A	126	TRP	CE2-CD2-CG	-6.86	101.81	107.30
1	A	211	TRP	CE2-CD2-CG	-6.80	101.86	107.30
1	A	211	TRP	CD1-CG-CD2	6.73	111.68	106.30
1	A	127	ARG	NE-CZ-NH2	-6.62	116.99	120.30
1	A	166	ARG	NE-CZ-NH1	6.59	123.60	120.30
1	A	51	TRP	CB-CG-CD1	-6.46	118.61	127.00
1	A	127	ARG	CB-CG-CD	-6.43	94.88	111.60
1	A	47	VAL	CG1-CB-CG2	6.29	120.97	110.90
1	A	31	ARG	NE-CZ-NH2	-6.27	117.17	120.30
1	A	148	ASP	CB-CG-OD1	5.98	123.68	118.30
1	A	162	ASN	N-CA-C	5.95	127.06	111.00
1	A	14	ARG	NE-CZ-NH2	-5.72	117.44	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	51	TRP	CG-CD1-NE1	-5.70	104.40	110.10
1	A	48	ARG	NE-CZ-NH2	-5.58	117.51	120.30
1	A	51	TRP	CG-CD2-CE3	5.55	138.90	133.90
1	A	223	TRP	CG-CD1-NE1	-5.54	104.56	110.10
1	A	79	ASP	CB-CG-OD1	5.47	123.22	118.30
1	A	62	ASN	CB-CG-ND2	5.35	129.53	116.70
1	A	127	ARG	NE-CZ-NH1	5.32	122.96	120.30
1	A	57	TRP	CG-CD2-CE3	5.29	138.66	133.90
1	A	166	ARG	NE-CZ-NH2	-5.25	117.67	120.30
1	A	101	TRP	CG-CD1-NE1	-5.23	104.87	110.10
1	A	256	ASP	N-CA-CB	-5.15	101.33	110.60
1	A	42	TYR	CB-CG-CD1	-5.13	117.92	121.00
1	A	256	ASP	CB-CG-OD1	5.07	122.86	118.30
1	A	72	ARG	NE-CZ-NH1	5.02	122.81	120.30

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	2338	503	2209	17	0
2	A	43	0	30	1	0
3	A	5	2	5	0	0
4	A	50	0	0	4	0
All	All	2436	505	2244	17	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 4.

All (17) 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:67:TYR:HA	1:A:130:ARG:HG2	1.70	0.72
1:A:53:ILE:HD13	1:A:108:PHE:HB2	1.81	0.63

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:166:ARG:HH21	1:A:257:LYS:NZ	2.00	0.60
1:A:130:ARG:NH2	4:A:326:HOH:O	2.41	0.53
1:A:237:SER:HA	1:A:240:GLN:HE21	1.76	0.50
1:A:175:HIS:HE1	2:A:295:HEM:NB	2.09	0.50
1:A:130:ARG:NE	4:A:326:HOH:O	2.39	0.49
1:A:156:THR:O	1:A:159:GLN:HB3	2.16	0.46
1:A:166:ARG:HH21	1:A:257:LYS:HZ2	1.63	0.46
1:A:17:GLU:H	1:A:17:GLU:CD	2.21	0.43
1:A:20:GLN:HE22	1:A:287:LYS:H	1.67	0.43
1:A:195:ASN:ND2	1:A:195:ASN:H	2.16	0.42
1:A:130:ARG:CZ	4:A:326:HOH:O	2.68	0.42
1:A:81:SER:HB2	1:A:144:LEU:HD12	2.01	0.42
1:A:48:ARG:NE	4:A:300:HOH:O	2.48	0.41
1:A:145:PRO:HD3	1:A:157:PHE:CZ	2.56	0.41
1:A:212:LYS:HE3	1:A:214:GLU:OE2	2.21	0.41

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	289/294 (98%)	282 (98%)	6 (2%)	1 (0%)	46 45

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	162	ASN

### 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	246 /251 (98%)	230 (94%)	16 (6%)	21	17

All (16) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	28	LEU
1	A	33	ASP
1	A	35	GLU
1	A	51	TRP
1	A	74	LYS
1	A	120	GLN
1	A	130	ARG
1	A	159	GLN
1	A	171	LEU
1	A	190	PRO
1	A	195	ASN
1	A	219	ASN
1	A	226	LYS
1	A	246	SER
1	A	256	ASP
1	A	278	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	20	GLN
1	A	24	ASN
1	A	195	ASN
1	A	220	ASN
1	A	240	GLN
1	A	292	GLN

### 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	HEM	A	295	1,4	30,50,50	4.02	12 (40%)	24,82,82	2.46	10 (41%)
3	IMD	A	296	-	5,5,5	1.18	0	4,5,5	1.45	1 (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	HEM	A	295	1,4	-	0/10/54/54	0/0/8/8
3	IMD	A	296	-	-	0/0/0/0	0/1/1/1

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	295	HEM	C3B-C4B	-13.65	1.39	1.51

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	295	HEM	C3D-C4D	-8.53	1.40	1.51
2	A	295	HEM	C2C-C1C	-7.00	1.39	1.52
2	A	295	HEM	C3B-CAB	-6.45	1.39	1.51
2	A	295	HEM	C3C-CAC	-5.46	1.41	1.51
2	A	295	HEM	C2D-C3D	-5.33	1.38	1.54
2	A	295	HEM	C2D-C1D	-3.89	1.39	1.51
2	A	295	HEM	C2B-C1B	-3.70	1.39	1.51
2	A	295	HEM	C1C-NC	-2.66	1.32	1.36
2	A	295	HEM	CBB-CAB	2.46	1.43	1.29
2	A	295	HEM	FE-NC	2.85	2.07	1.95
2	A	295	HEM	CBC-CAC	2.89	1.46	1.29

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	296	IMD	C5-C4-N3	-2.03	103.01	106.99
2	A	295	HEM	C3B-C4B-CHC	2.09	126.11	123.16
2	A	295	HEM	CMD-C2D-C3D	2.16	123.88	114.35
2	A	295	HEM	C4B-CHC-C1C	2.18	129.46	125.82
2	A	295	HEM	C2D-C3D-C4D	2.54	105.81	101.50
2	A	295	HEM	C1D-CHD-C4C	2.72	130.37	125.82
2	A	295	HEM	C3C-CAC-CBC	2.99	129.04	124.46
2	A	295	HEM	CAD-C3D-C2D	3.61	123.59	113.22
2	A	295	HEM	CAD-C3D-C4D	5.08	130.39	112.47
2	A	295	HEM	CMB-C2B-C3B	5.40	130.00	116.53
2	A	295	HEM	CMC-C2C-C3C	5.52	130.31	116.53

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	295	HEM	1	0

## 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 [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	291/294 (98%)	-0.27	4 (1%) 78 82	6, 16, 29, 39	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	278	LYS	3.2
1	A	47	VAL	2.2
1	A	159	GLN	2.1
1	A	17	GLU	2.1

### 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(Å <sup>2</sup> )	Q<0.9
3	IMD	A	296	5/5	0.79	0.22	5.08	15,15,15,15	0
2	HEM	A	295	43/43	0.97	0.11	-0.09	4,8,15,22	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.