



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 05:05 PM GMT

PDB ID : 4H23  
Title : Cytochrome P411BM3-CIS cyclopropanation catalyst  
Authors : Coelho, P.S.; Wang, Z.J.; Ener, M.E.; Baril, S.A.; Kannan, A.; Arnold, F.H.;  
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Deposited on : 2012-09-11  
Resolution : 3.30 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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

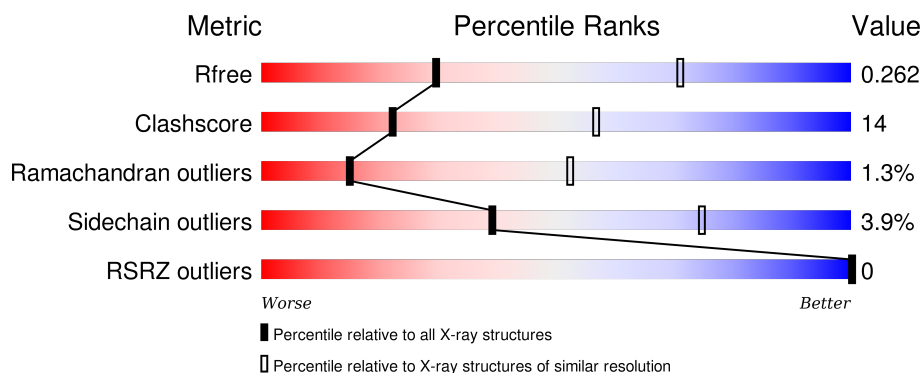
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*



The reported resolution of this entry is 3.30 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))
$R_{free}$	91344	2060 (3.40-3.20)
Clashscore	102246	1058 (3.38-3.22)
Ramachandran outliers	100387	1038 (3.38-3.22)
Sidechain outliers	100360	1037 (3.38-3.22)
RSRZ outliers	91569	2070 (3.40-3.20)

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	470	 69% 26% • •
1	B	470	 64% 30% • 5%

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 7000 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 Cytochrome P450-BM3 variant P411BM3-Cis.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	454	Total	C	N	O	S	0	0	0
			3482	2238	592	636	16			
1	B	448	Total	C	N	O	S	0	0	0
			3408	2195	580	617	16			

There are 40 discrepancies between the modelled and reference sequences:

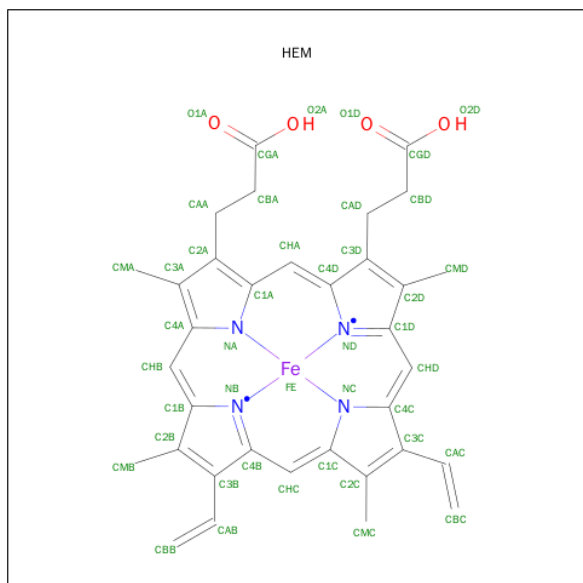
Chain	Residue	Modelled	Actual	Comment	Reference
A	78	ALA	VAL	ENGINEERED MUTATION	UNP P14779
A	87	VAL	PHE	ENGINEERED MUTATION	UNP P14779
A	142	SER	PRO	ENGINEERED MUTATION	UNP P14779
A	175	ILE	THR	ENGINEERED MUTATION	UNP P14779
A	184	VAL	ALA	ENGINEERED MUTATION	UNP P14779
A	226	ARG	SER	ENGINEERED MUTATION	UNP P14779
A	236	GLN	HIS	ENGINEERED MUTATION	UNP P14779
A	252	GLY	GLU	ENGINEERED MUTATION	UNP P14779
A	268	ALA	THR	ENGINEERED MUTATION	UNP P14779
A	290	VAL	ALA	ENGINEERED MUTATION	UNP P14779
A	353	VAL	LEU	ENGINEERED MUTATION	UNP P14779
A	366	VAL	ILE	ENGINEERED MUTATION	UNP P14779
A	400	SER	CYS	ENGINEERED MUTATION	UNP P14779
A	442	LYS	GLU	ENGINEERED MUTATION	UNP P14779
A	464	HIS	-	EXPRESSION TAG	UNP P14779
A	465	HIS	-	EXPRESSION TAG	UNP P14779
A	466	HIS	-	EXPRESSION TAG	UNP P14779
A	467	HIS	-	EXPRESSION TAG	UNP P14779
A	468	HIS	-	EXPRESSION TAG	UNP P14779
A	469	HIS	-	EXPRESSION TAG	UNP P14779
B	78	ALA	VAL	ENGINEERED MUTATION	UNP P14779
B	87	VAL	PHE	ENGINEERED MUTATION	UNP P14779
B	142	SER	PRO	ENGINEERED MUTATION	UNP P14779
B	175	ILE	THR	ENGINEERED MUTATION	UNP P14779
B	184	VAL	ALA	ENGINEERED MUTATION	UNP P14779

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Chain	Residue	Modelled	Actual	Comment	Reference
B	226	ARG	SER	ENGINEERED MUTATION	UNP P14779
B	236	GLN	HIS	ENGINEERED MUTATION	UNP P14779
B	252	GLY	GLU	ENGINEERED MUTATION	UNP P14779
B	268	ALA	THR	ENGINEERED MUTATION	UNP P14779
B	290	VAL	ALA	ENGINEERED MUTATION	UNP P14779
B	353	VAL	LEU	ENGINEERED MUTATION	UNP P14779
B	366	VAL	ILE	ENGINEERED MUTATION	UNP P14779
B	400	SER	CYS	ENGINEERED MUTATION	UNP P14779
B	442	LYS	GLU	ENGINEERED MUTATION	UNP P14779
B	464	HIS	-	EXPRESSION TAG	UNP P14779
B	465	HIS	-	EXPRESSION TAG	UNP P14779
B	466	HIS	-	EXPRESSION TAG	UNP P14779
B	467	HIS	-	EXPRESSION TAG	UNP P14779
B	468	HIS	-	EXPRESSION TAG	UNP P14779
B	469	HIS	-	EXPRESSION TAG	UNP P14779

- 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
			43	34	1	4	4	
2	B	1	Total	C	Fe	N	O	0
			43	34	1	4	4	

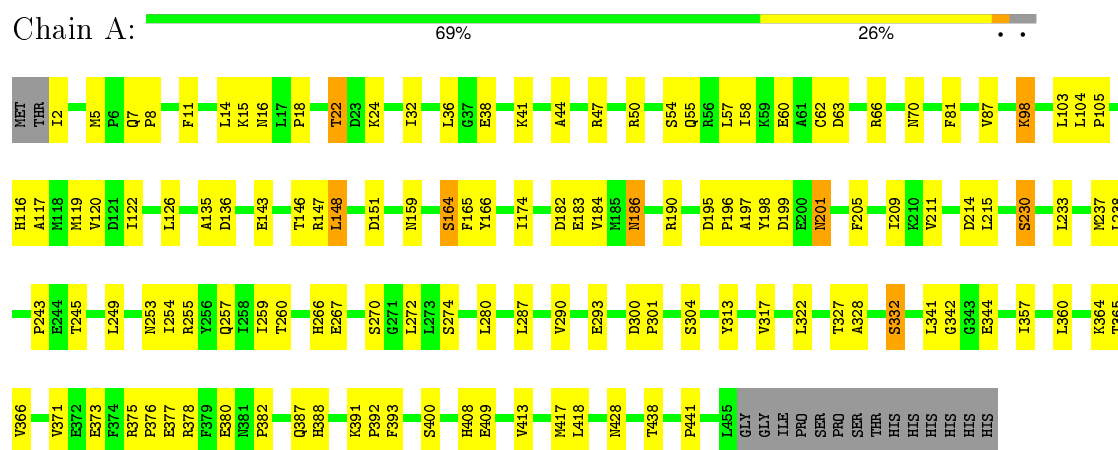
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	6	Total 6	O 6	0	0
3	B	18	Total 18	O 18	0	0

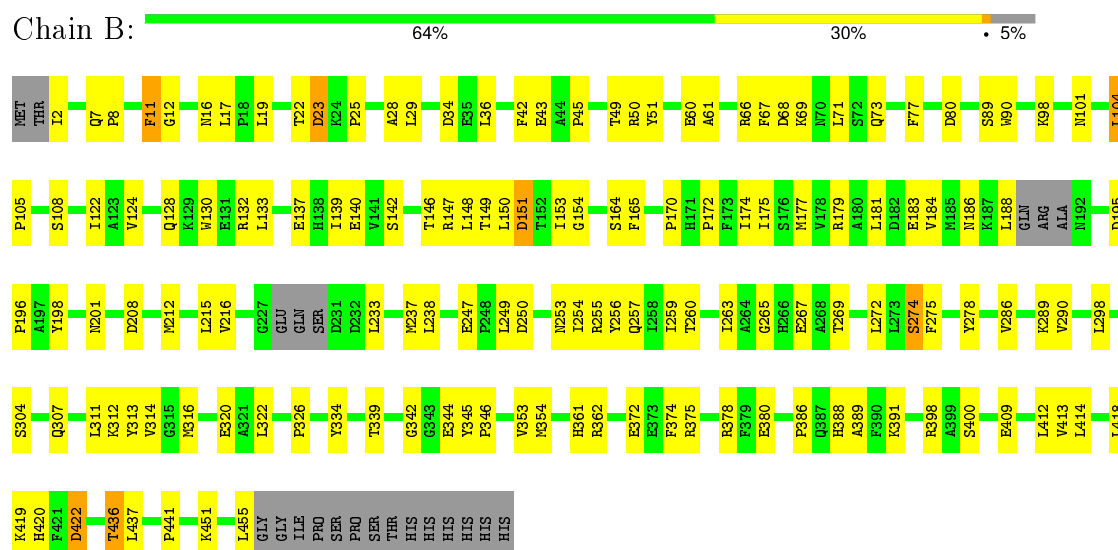
### 3 Residue-property plots

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 P450-BM3 variant P411BM3-Cis



#### • Molecule 1: Cytochrome P450-BM3 variant P411BM3-Cis



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 2 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	63.16Å 124.45Å 127.69Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	44.90 – 3.30 44.90 – 3.30	Depositor EDS
% Data completeness (in resolution range)	99.8 (44.90-3.30) 99.8 (44.90-3.30)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.18	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.84 (at 3.32Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, $R_{free}$	0.179 , 0.265 0.177 , 0.262	Depositor DCC
$R_{free}$ test set	831 reflections (5.58%)	DCC
Wilson B-factor (Å <sup>2</sup> )	53.8	Xtriage
Anisotropy	0.095	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.31 , 52.3	EDS
Estimated twinning fraction	0.023 for -h,l,k	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Outliers	0 of 15715 reflections	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	7000	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	38.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.97% 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

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	0.74	1/3564 (0.0%)	0.80	1/4842 (0.0%)
1	B	0.72	2/3488 (0.1%)	0.77	0/4745
All	All	0.73	3/7052 (0.0%)	0.79	1/9587 (0.0%)

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	B	0	1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	143	GLU	CG-CD	5.47	1.60	1.51
1	B	267	GLU	CG-CD	5.18	1.59	1.51
1	B	140	GLU	CG-CD	5.02	1.59	1.51

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	249	LEU	CA-CB-CG	5.49	127.92	115.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	11	PHE	Peptide



## 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	3482	0	3327	89	0
1	B	3408	0	3239	97	0
2	A	43	0	30	1	0
2	B	43	0	30	6	0
3	A	6	0	0	1	0
3	B	18	0	0	1	0
All	All	7000	0	6626	188	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 14.

The worst 5 of 188 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:422:ASP:OD1	1:B:451:LYS:HE2	1.71	0.91
1:B:388:HIS:ND1	1:B:391:LYS:NZ	2.25	0.85
1:B:286:VAL:O	1:B:290:VAL:HG23	1.77	0.84
1:A:2:ILE:HG22	1:A:344:GLU:HA	1.57	0.84
1:A:196:PRO:HA	1:A:198:TYR:N	1.93	0.83

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	452/470 (96%)	400 (88%)	46 (10%)	6 (1%)	15 52

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	442/470 (94%)	387 (88%)	49 (11%)	6 (1%)	14	50
All	All	894/940 (95%)	787 (88%)	95 (11%)	12 (1%)	15	52

5 of 12 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	197	ALA
1	A	230	SER
1	A	245	THR
1	A	377	GLU
1	B	45	PRO

### 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	348/411 (85%)	333 (96%)	15 (4%)	35	72
1	B	338/411 (82%)	326 (96%)	12 (4%)	42	76
All	All	686/822 (84%)	659 (96%)	27 (4%)	39	75

5 of 27 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	365	THR
1	B	23	ASP
1	B	422	ASP
1	A	371	VAL
1	A	164	SER

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 6 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	426	HIS
1	B	201	ASN

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Mol	Chain	Res	Type
1	B	7	GLN
1	A	201	ASN
1	B	16	ASN

### 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	500	1	30,50,50	2.14	7 (23%)	24,82,82	2.36	9 (37%)
2	HEM	B	500	1	30,50,50	2.40	7 (23%)	24,82,82	2.33	8 (33%)

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	500	1	-	0/10/54/54	0/0/8/8

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	HEM	B	500	1	-	0/10/54/54	0/0/8/8

The worst 5 of 14 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	500	HEM	C3B-C4B	-8.89	1.43	1.51
2	A	500	HEM	C3B-C4B	-6.30	1.46	1.51
2	A	500	HEM	C2C-C1C	-5.30	1.42	1.52
2	A	500	HEM	C3D-C4D	-5.27	1.44	1.51
2	B	500	HEM	C3D-C4D	-4.21	1.46	1.51

The worst 5 of 17 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	500	HEM	CMA-C3A-C4A	-3.30	122.91	128.36
2	A	500	HEM	C3C-CAC-CBC	-3.25	119.47	124.46
2	B	500	HEM	C3B-CAB-CBB	-2.72	120.28	124.46
2	A	500	HEM	CAA-C2A-C1A	-2.35	124.45	127.01
2	B	500	HEM	C2C-C1C-CHC	2.22	127.05	123.68

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	500	HEM	1	0
2	B	500	HEM	6	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, 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	454/470 (96%)	-0.45	0 100 100	19, 35, 57, 70	0
1	B	448/470 (95%)	-0.41	0 100 100	20, 41, 65, 87	0
All	All	902/940 (95%)	-0.43	0 100 100	19, 38, 61, 87	0

There are no RSRZ outliers to report.

### 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
2	HEM	B	500	43/43	0.97	0.19	0.63	26,31,42,45	0
2	HEM	A	500	43/43	0.98	0.19	0.33	18,22,27,29	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.