Full wwPDB Geometry-Only Validation Report (i)

May 23, 2024 – 09:23 AM EDT

PDB ID	:	2MB5
Title	:	HYDRATION IN PROTEIN CRYSTALS. A NEUTRON DIFFRACTION ANALYSIS OF CARBONMONOXYMYOGLOBIN
Authors	:	Schoenborn, B.P.; Cheng, X.
Deposited on	:	1989-10-11
Resolution	:	1.80 Å(reported)

This is a Full wwPDB Geometry-Only Validation Report for a publicly released PDB entry.

We welcome your comments at *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 (i) symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

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

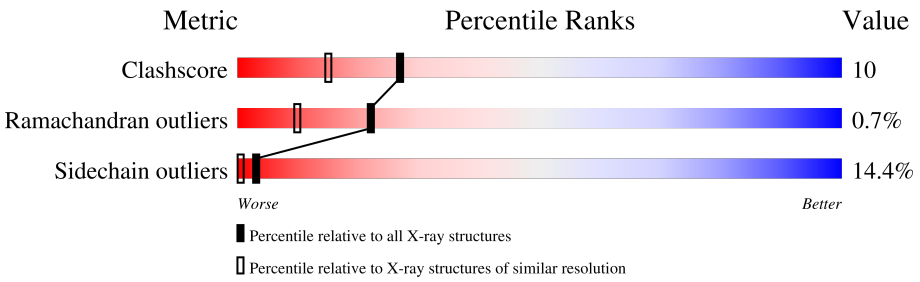
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36.2

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
NEUTRON DIFFRACTION

The reported resolution of this entry is 1.80 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	141614	6793 (1.80-1.80)
Ramachandran outliers	138981	6697 (1.80-1.80)
Sidechain outliers	138945	6696 (1.80-1.80)

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 of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. 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 <=5%

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	153	68% 22% 9% •

2 Entry composition (i)

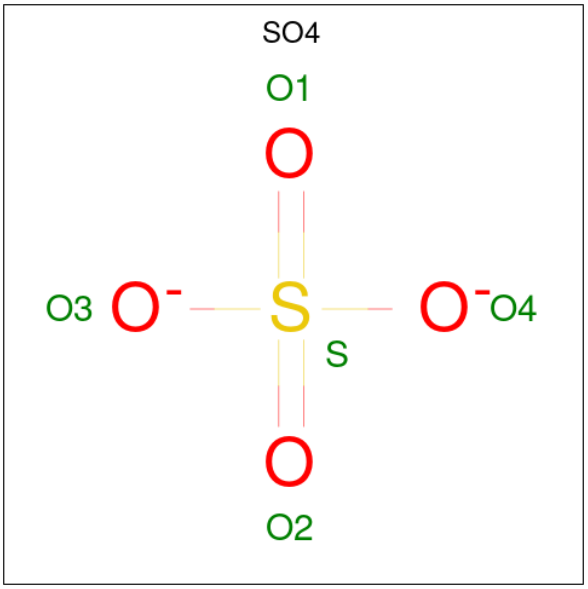
There are 6 unique types of molecules in this entry. The entry contains 2842 atoms, of which 1004 are hydrogens and 475 are deuteriums.

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.

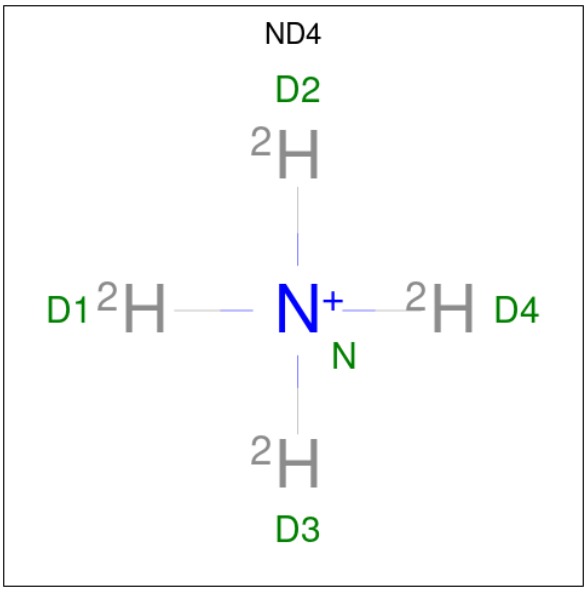
Mol	Chain	Residues	Atoms							ZeroOcc	AltConf	Trace
			Total	C	D	H	N	O	S			
1	A	153	2468	783	277	974	216	216	2	0	0	0

- Molecule 2 is SULFATE ION (three-letter code: SO4) (formula: O_4S).



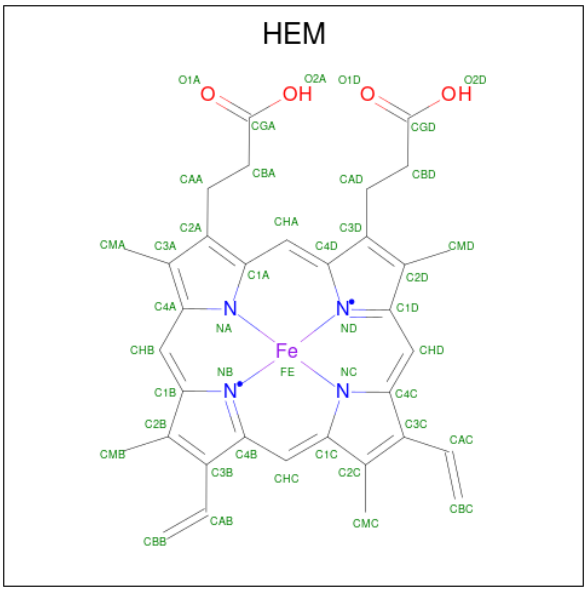
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	O	S		
2	A	1	5	4	1	0	0

- Molecule 3 is AMMONIUM CATION WITH D (three-letter code: ND4) (formula: N).



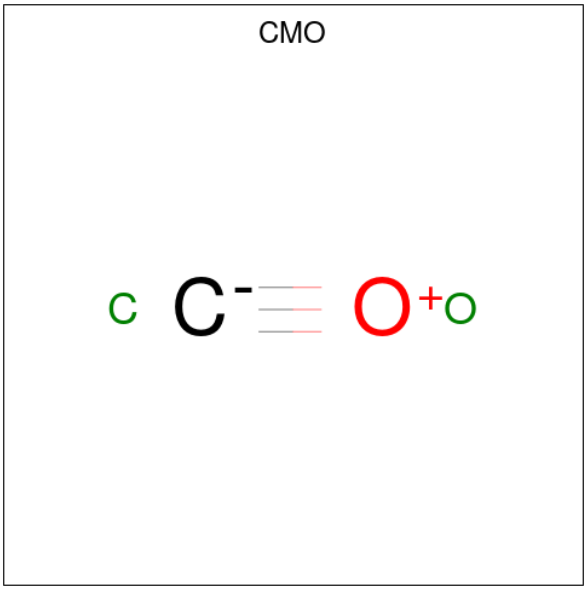
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	D	N		
3	A	1	5	4	1	0	0
3	A	1	5	4	1	0	0
3	A	1	5	4	1	0	0
3	A	1	5	4	1	0	0
3	A	1	5	4	1	0	0

- Molecule 4 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
			Total	C	Fe	H	N	O		
4	A	1	73	34	1	30	4	4	0	0

- Molecule 5 is CARBON MONOXIDE (three-letter code: CMO) (formula: CO).



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

- Molecule 6 is water.

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	D	O		
6	A	89	267	178	89	0	0

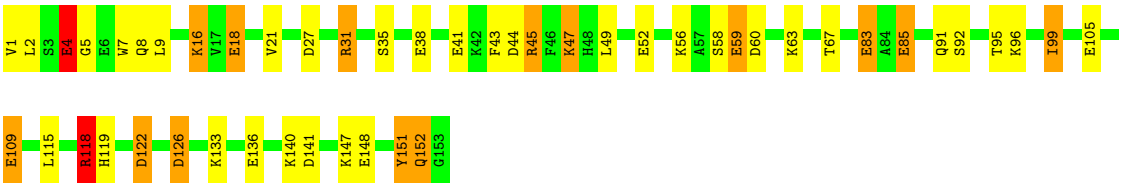
3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide 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.

Note EDS was not executed.

- Molecule 1: MYOGLOBIN

Chain A:



4 Model quality (i)

4.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: HEM, SO4, DOD, CMO, ND4

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	12/1245 (1.0%)	1.69	20/1671 (1.2%)

All (12) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	52	GLU	CD-OE2	6.25	1.32	1.25
1	A	109	GLU	CD-OE2	6.03	1.32	1.25
1	A	83	GLU	CD-OE2	5.99	1.32	1.25
1	A	105	GLU	CD-OE2	5.77	1.31	1.25
1	A	18	GLU	CD-OE2	5.67	1.31	1.25
1	A	59	GLU	CD-OE2	5.55	1.31	1.25
1	A	41	GLU	CD-OE2	5.54	1.31	1.25
1	A	4	GLU	CD-OE2	5.52	1.31	1.25
1	A	85	GLU	CD-OE2	5.36	1.31	1.25
1	A	136	GLU	CD-OE2	5.36	1.31	1.25
1	A	148	GLU	CD-OE2	5.35	1.31	1.25
1	A	38	GLU	CD-OE2	5.02	1.31	1.25

All (20) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	47	LYS	CD-CE-NZ	18.64	154.56	111.70
1	A	141	ASP	CB-CG-OD1	11.01	128.21	118.30
1	A	136	GLU	N-CA-CB	9.44	127.59	110.60
1	A	27	ASP	CB-CG-OD2	-9.35	109.89	118.30
1	A	91	GLN	CB-CA-C	8.75	127.90	110.40
1	A	126	ASP	CA-CB-CG	8.74	132.63	113.40
1	A	27	ASP	CB-CG-OD1	8.51	125.96	118.30
1	A	45	ARG	NE-CZ-NH1	8.48	124.54	120.30
1	A	60	ASP	CB-CG-OD2	-8.04	111.07	118.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	56	LYS	CG-CD-CE	7.48	134.33	111.90
1	A	122	ASP	CB-CG-OD2	-6.31	112.62	118.30
1	A	44	ASP	CB-CG-OD2	-6.24	112.68	118.30
1	A	118	ARG	NE-CZ-NH2	6.01	123.31	120.30
1	A	83	GLU	CA-CB-CG	5.77	126.10	113.40
1	A	4	GLU	OE1-CD-OE2	-5.66	116.50	123.30
1	A	4	GLU	CG-CD-OE1	5.47	129.24	118.30
1	A	35	SER	CA-CB-OG	5.43	125.85	111.20
1	A	151	TYR	CB-CG-CD1	5.27	124.16	121.00
1	A	140	LYS	CD-CE-NZ	5.14	123.53	111.70
1	A	60	ASP	CB-CG-OD1	5.09	122.89	118.30

There are no chirality outliers.

There are no planarity outliers.

4.2 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	1494	974	1242	25	2
2	A	5	0	0	0	0
3	A	25	0	0	2	0
4	A	43	30	30	5	0
5	A	4	0	0	0	0
6	A	267	0	0	10	0
All	All	1838	1004	1272	26	2

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 10.

All (26) 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:118:ARG:HH11	1:A:118:ARG:HG2	1.24	0.91
1:A:118:ARG:HH11	1:A:118:ARG:CG	1.83	0.84
1:A:147:LYS:HB2	1:A:152:GLN:HG3	1.55	0.78

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:16:LYS:NZ	1:A:122:ASP:OD1	2.17	0.78
1:A:4:GLU:HB2	6:A:253:DOD:O	1.83	0.72
1:A:118:ARG:HG2	1:A:118:ARG:NH1	1.96	0.70
1:A:133:LYS:HD3	6:A:289:DOD:O	1.90	0.67
1:A:118:ARG:CG	1:A:118:ARG:NH1	2.52	0.63
1:A:126:ASP:OD2	3:A:178:ND4:N	2.34	0.59
3:A:283:ND4:N	6:A:271:DOD:O	2.35	0.59
1:A:43:PHE:O	1:A:47:LYS:HG3	1.99	0.58
1:A:1:VAL:HA	6:A:255:DOD:O	2.01	0.55
1:A:67:THR:HA	6:A:211:DOD:O	2.02	0.55
1:A:99:ILE:CD1	4:A:154:HEM:HHD	2.33	0.53
1:A:31:ARG:NH2	6:A:232:DOD:O	2.42	0.51
1:A:58:SER:HA	6:A:240:DOD:O	2.07	0.50
1:A:99:ILE:CD1	4:A:154:HEM:CHD	2.91	0.49
1:A:99:ILE:HD11	4:A:154:HEM:HHD	1.84	0.48
1:A:5:GLY:O	6:A:225:DOD:O	2.24	0.48
1:A:133:LYS:CD	6:A:289:DOD:O	2.58	0.48
1:A:7:TRP:CD1	6:A:286:DOD:O	2.59	0.47
1:A:118:ARG:HB3	1:A:119:HIS:CD2	2.47	0.45
1:A:99:ILE:HD11	4:A:154:HEM:CHD	2.43	0.44
1:A:16:LYS:NZ	1:A:122:ASP:CG	2.70	0.44
1:A:95:THR:HG22	1:A:151:TYR:CE2	2.50	0.41
1:A:99:ILE:HD12	4:A:154:HEM:C3C	2.51	0.41

All (2) 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)
1:A:96:LYS:HE2	1:A:109:GLU:OE2[1_565]	0.91	0.69
1:A:96:LYS:CE	1:A:109:GLU:OE2[1_565]	1.94	0.26

4.3 Torsion angles (i)

4.3.1 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	151/153 (99%)	144 (95%)	6 (4%)	1 (1%)	22 10

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	2	LEU

4.3.2 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	125/125 (100%)	107 (86%)	18 (14%)	3 0

All (18) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	4	GLU
1	A	8	GLN
1	A	9	LEU
1	A	16	LYS
1	A	18	GLU
1	A	21	VAL
1	A	31	ARG
1	A	45	ARG
1	A	49	LEU
1	A	59	GLU
1	A	63	LYS
1	A	83	GLU
1	A	85	GLU
1	A	92	SER
1	A	99	ILE
1	A	115	LEU
1	A	118	ARG
1	A	152	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	91	GLN

4.3.3 RNA (i)

There are no RNA molecules in this entry.

4.4 Non-standard residues in protein, DNA, RNA chains (i)

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

4.5 Carbohydrates (i)

There are no monosaccharides in this entry.

4.6 Ligand geometry (i)

Of 9 ligands modelled in this entry, 5 are modelled with single atom - leaving 4 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	$\#\|Z\| > 2$
4	HEM	A	154	5,1	41,50,50	1.45	5 (12%)	45,82,82	2.17	10 (22%)
2	SO4	A	174	-	4,4,4	0.60	0	6,6,6	0.06	0
5	CMO	A	155[B]	4	0,1,1	-	-	-		
5	CMO	A	155[A]	4	0,1,1	-	-	-		

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
4	HEM	A	154	5,1	-	7/12/54/54	-

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	154	HEM	C3C-C2C	-4.16	1.34	1.40
4	A	154	HEM	C3C-CAC	3.41	1.54	1.47
4	A	154	HEM	CAB-C3B	2.54	1.54	1.47
4	A	154	HEM	CMD-C2D	2.18	1.55	1.50
4	A	154	HEM	CMB-C2B	2.04	1.55	1.50

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	154	HEM	CBA-CAA-C2A	7.29	125.06	112.62
4	A	154	HEM	C4B-CHC-C1C	6.34	130.93	122.56
4	A	154	HEM	CMA-C3A-C4A	-5.01	120.76	128.46
4	A	154	HEM	CAA-CBA-CGA	4.08	125.19	113.76
4	A	154	HEM	CHC-C4B-NB	-3.16	120.99	124.43
4	A	154	HEM	CMA-C3A-C2A	2.85	130.31	124.94
4	A	154	HEM	C4A-C3A-C2A	2.77	108.92	107.00
4	A	154	HEM	CMC-C2C-C3C	2.69	129.72	124.68
4	A	154	HEM	O2A-CGA-CBA	2.14	120.90	114.03
4	A	154	HEM	CHC-C4B-C3B	2.02	127.65	124.57

There are no chirality outliers.

All (7) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	154	HEM	C2A-CAA-CBA-CGA
4	A	154	HEM	C2B-C3B-CAB-CBB
4	A	154	HEM	C4B-C3B-CAB-CBB
4	A	154	HEM	CAD-CBD-CGD-O2D
4	A	154	HEM	CAD-CBD-CGD-O1D
4	A	154	HEM	CAA-CBA-CGA-O2A
4	A	154	HEM	CAA-CBA-CGA-O1A

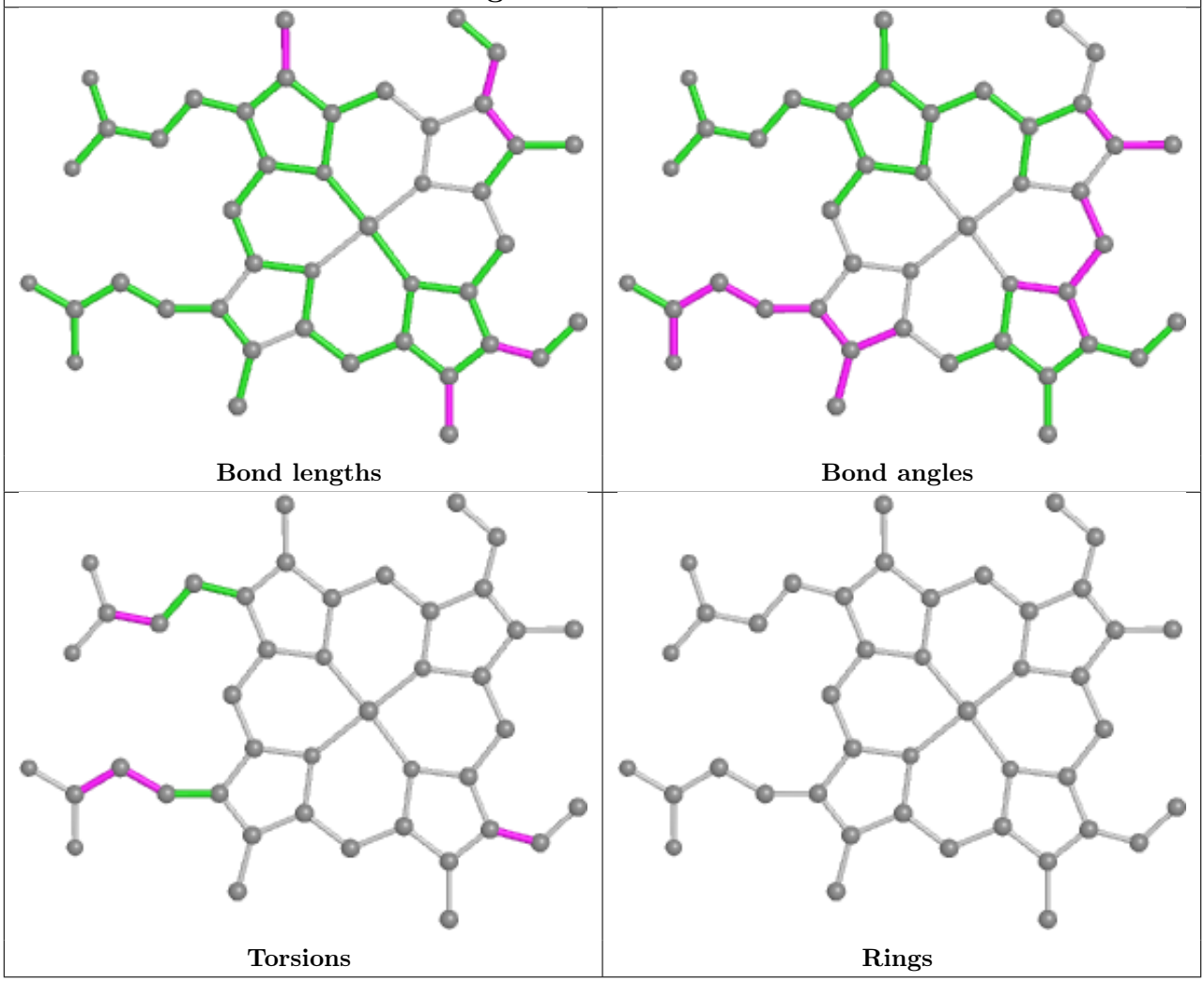
There are no ring outliers.

1 monomer is involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	154	HEM	5	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand HEM A 154



4.7 Other polymers (i)

There are no such residues in this entry.

4.8 Polymer linkage issues (i)

There are no chain breaks in this entry.