



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 12:11 PM UTC

PDB ID : 5Y34 / pdb_00005y34
Title : Membrane-bound respiratory [NiFe]-hydrogenase from *Hydrogenovibrio marinus* in a ferricyanide-oxidized condition
Authors : Shomura, Y.; Yoon, K.S.; Nishihara, H.; Higuchi, Y.
Deposited on : 2017-07-27
Resolution : 1.32 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

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ 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 ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

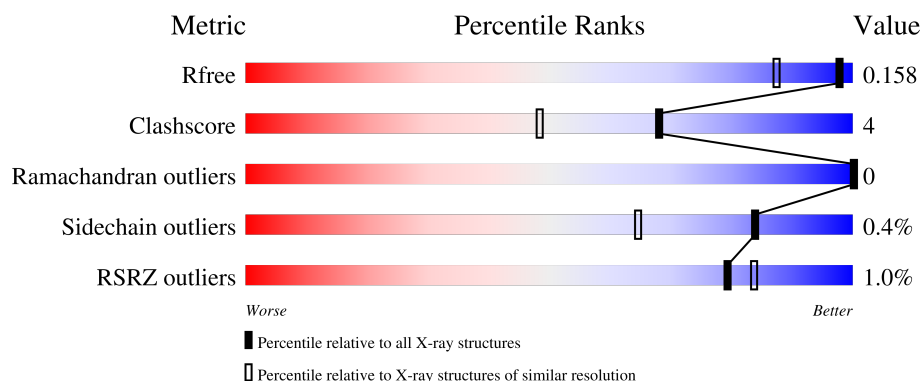
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.32 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}	180053	2531 (1.34-1.30)
Clashscore	190562	2585 (1.34-1.30)
Ramachandran outliers	187476	2528 (1.34-1.30)
Sidechain outliers	187428	2528 (1.34-1.30)
RSRZ outliers	180081	2528 (1.34-1.30)

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 $\leq 5\%$. 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	596	93% 6% .
1	C	596	% 94% 6%
2	B	283	3% 87% 10% .
2	D	283	% 88% 7% 6%

2 Entry composition

There are 11 unique types of molecules in this entry. The entry contains 16334 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 Hydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	595	Total	C	N	O	S	0	36	0
			4865	3103	839	896	27			
1	C	595	Total	C	N	O	S	0	26	0
			4811	3059	834	891	27			

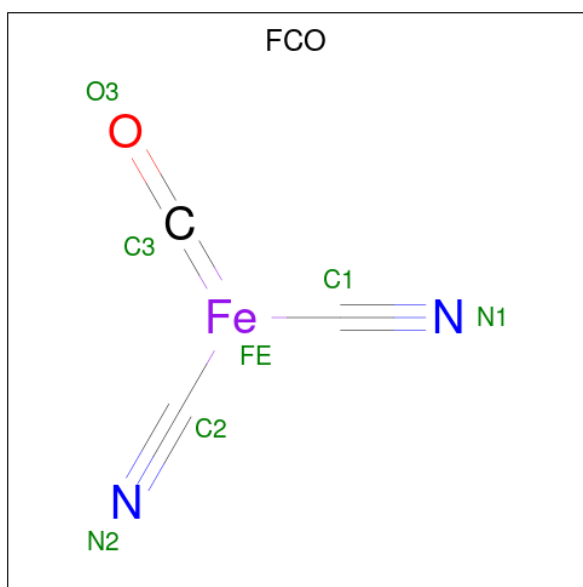
- Molecule 2 is a protein called Membrane-bound hydrogenase small subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	273	Total	C	N	O	S	0	23	0
			2251	1446	376	406	23			
2	D	267	Total	C	N	O	S	0	11	0
			2128	1354	361	392	21			

- Molecule 3 is NICKEL (III) ION (CCD ID: 3NI) (formula: Ni).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Ni	0	0
			1	1		
3	C	1	Total	Ni	0	0
			1	1		

- Molecule 4 is CARBONMONOXIDE-(DICYANO) IRON (CCD ID: FCO) (formula: C₃FeN₂O).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	Fe	N	O	0	0
			7	3	1	2	1		
4	C	1	Total	C	Fe	N	O	0	0
			7	3	1	2	1		

- Molecule 5 is OXYGEN ATOM (CCD ID: O) (formula: O).

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

- Molecule 6 is GLYCEROL (CCD ID: GOL) (formula: C₃H₈O₃).

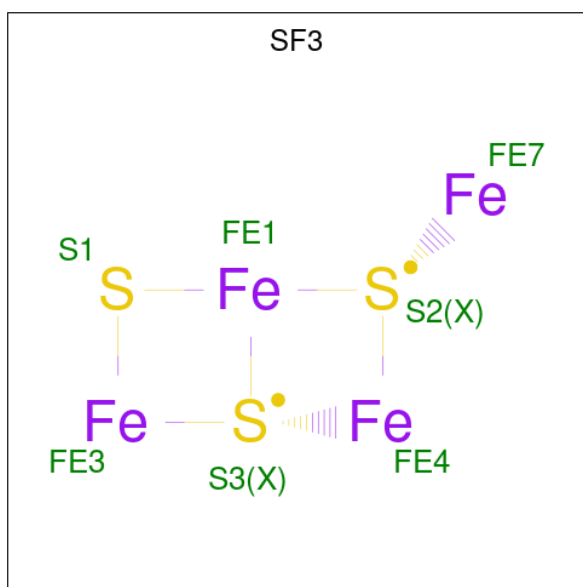


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			6	3	3		
6	A	1	Total	C	O	0	0
			6	3	3		
6	C	1	Total	C	O	0	0
			6	3	3		
6	C	1	Total	C	O	0	0
			6	3	3		

- Molecule 7 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

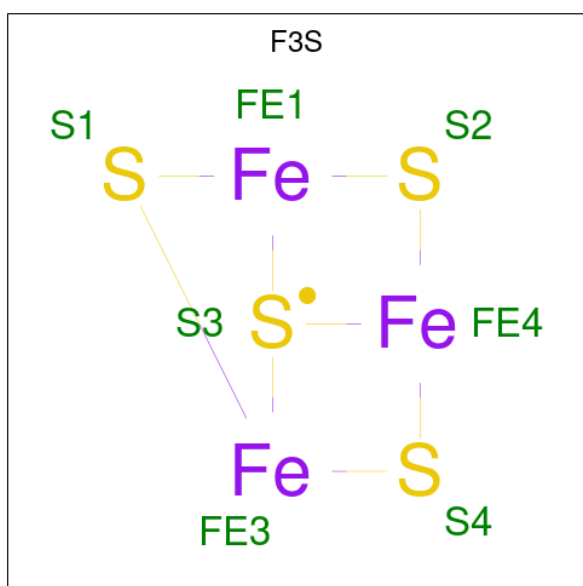
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	1	Total	Mg	0	0
			1	1		
7	C	1	Total	Mg	0	0
			1	1		

- Molecule 8 is FE4-S3 CLUSTER (CCD ID: SF3) (formula: Fe₄S₃).



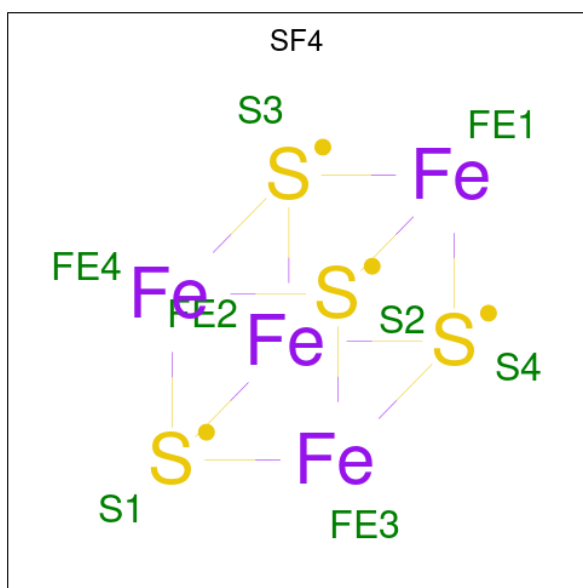
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
8	B	1	Total	Fe	S	0	1
			8	5	3		
8	D	1	Total	Fe	S	0	1
			8	5	3		

- Molecule 9 is FE3-S4 CLUSTER (CCD ID: F3S) (formula: Fe_3S_4).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
9	B	1	Total	Fe	S	0	0
			7	3	4		
9	D	1	Total	Fe	S	0	0
			7	3	4		

- Molecule 10 is IRON/SULFUR CLUSTER (CCD ID: SF4) (formula: Fe_4S_4).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
10	B	1	Total	Fe	S	0	0
			8	4	4		
10	D	1	Total	Fe	S	0	0
			8	4	4		

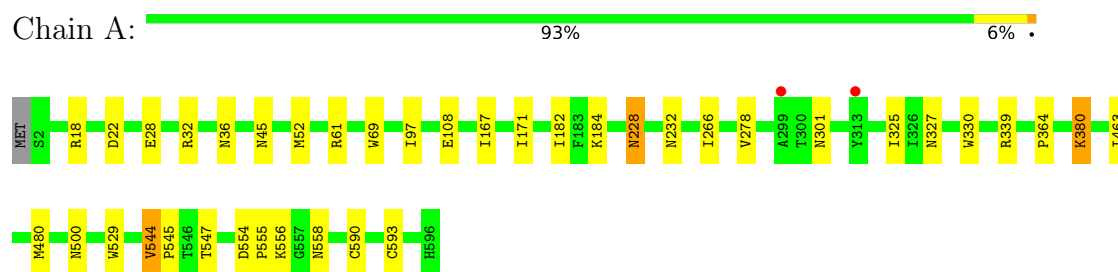
- Molecule 11 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
11	A	801	Total	O	0	0
			801	801		
11	B	336	Total	O	0	0
			336	336		
11	C	739	Total	O	0	0
			739	739		
11	D	313	Total	O	0	0
			313	313		

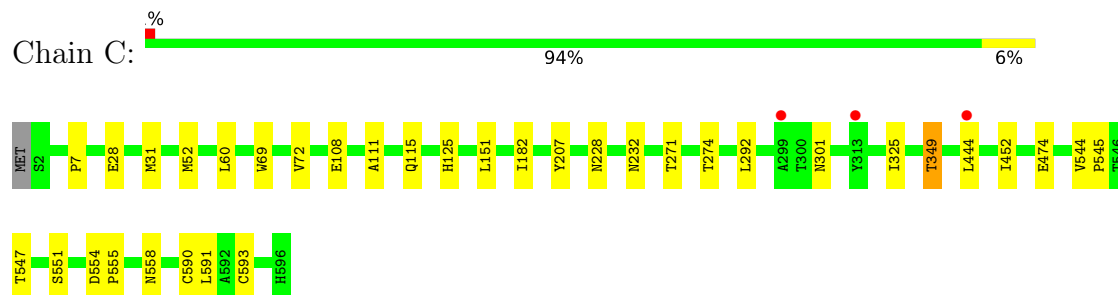
3 Residue-property plots [i](#)

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 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.

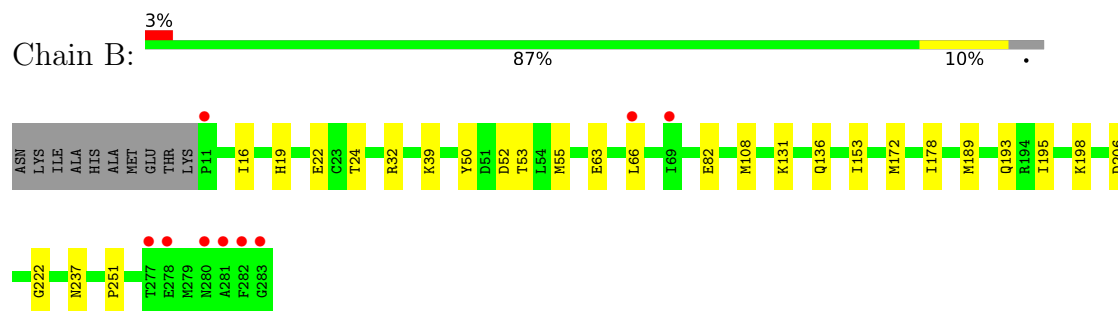
• Molecule 1: Hydrogenase



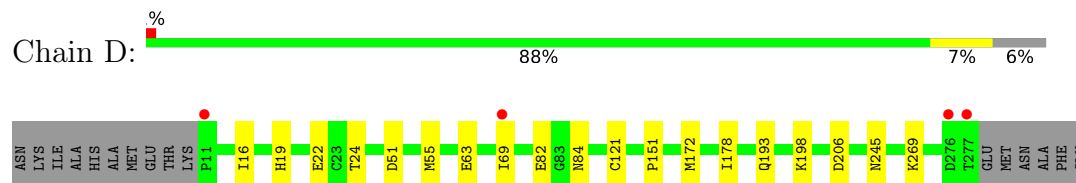
• Molecule 1: Hydrogenase



• Molecule 2: Membrane-bound hydrogenase small subunit



• Molecule 2: Membrane-bound hydrogenase small subunit



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	75.63Å 116.94Å 113.34Å 90.00° 91.42° 90.00°	Depositor
Resolution (Å)	19.89 – 1.32 19.89 – 1.32	Depositor EDS
% Data completeness (in resolution range)	97.3 (19.89-1.32) 97.3 (19.89-1.32)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.44 (at 1.32Å)	Xtriage
Refinement program	REFMAC 5.7.0029	Depositor
R, R_{free}	0.131 , 0.158 0.130 , 0.158	Depositor DCC
R_{free} test set	22644 reflections (4.87%)	wwPDB-VP
Wilson B-factor (Å ²)	12.0	Xtriage
Anisotropy	0.274	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 53.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	0.007 for -h,-l,-k 0.000 for -h,l,k 0.090 for h,-k,-l	Xtriage
F_o, F_c correlation	0.98	EDS
Total number of atoms	16334	wwPDB-VP
Average B, all atoms (Å ²)	19.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.06% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: SF4, F3S, GOL, MG, 3NI, FCO, O, SF3

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	0.56	0/5105	0.77	1/6941 (0.0%)
1	C	0.50	0/5017	0.73	0/6826
2	B	0.55	0/2382	0.81	4/3220 (0.1%)
2	D	0.51	0/2215	0.76	1/2997 (0.0%)
All	All	0.53	0/14719	0.76	6/19984 (0.0%)

There are no bond length outliers.

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	131[A]	LYS	CA-C-N	5.07	128.56	122.23
2	B	131[A]	LYS	C-N-CA	5.07	128.56	122.23
2	B	131[B]	LYS	CA-C-N	5.07	128.56	122.23
2	B	131[B]	LYS	C-N-CA	5.07	128.56	122.23
2	D	84	ASN	N-CA-C	5.06	114.12	108.25

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	4865	0	4858	41	0
1	C	4811	0	4766	27	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	2251	0	2265	29	0
2	D	2128	0	2088	17	0
3	A	1	0	0	0	0
3	C	1	0	0	0	0
4	A	7	0	0	0	0
4	C	7	0	0	0	0
5	A	1	0	0	1	0
5	C	1	0	0	1	0
6	A	12	0	16	0	0
6	C	12	0	16	0	0
7	A	1	0	0	0	0
7	C	1	0	0	0	0
8	B	8	0	0	0	0
8	D	8	0	0	0	0
9	B	7	0	0	0	0
9	D	7	0	0	0	0
10	B	8	0	0	0	0
10	D	8	0	0	0	0
11	A	801	0	0	12	0
11	B	336	0	0	2	0
11	C	739	0	0	7	0
11	D	313	0	0	4	0
All	All	16334	0	14009	102	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.

The worst 5 of 102 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)
2:B:50[A]:TYR:CE2	2:B:66[A]:LEU:HD11	1.83	1.13
1:A:184[C]:LYS:HE2	11:B:466:HOH:O	1.69	0.92
1:C:452:ILE:HD11	11:C:805:HOH:O	1.70	0.92
1:A:556[A]:LYS:HE2	11:A:824:HOH:O	1.71	0.90
1:A:182[B]:ILE:HG13	2:B:55[B]:MET:HA	1.54	0.90

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	630/596 (106%)	617 (98%)	13 (2%)	0	100	100
1	C	620/596 (104%)	610 (98%)	10 (2%)	0	100	100
2	B	296/283 (105%)	283 (96%)	13 (4%)	0	100	100
2	D	276/283 (98%)	265 (96%)	11 (4%)	0	100	100
All	All	1822/1758 (104%)	1775 (97%)	47 (3%)	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	541/505 (107%)	536 (99%)	5 (1%)	70	40
1	C	531/505 (105%)	528 (99%)	3 (1%)	78	54
2	B	250/233 (107%)	248 (99%)	2 (1%)	73	45
2	D	232/233 (100%)	232 (100%)	0	100	100
All	All	1554/1476 (105%)	1544 (99%)	10 (1%)	84	54

5 of 10 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	349[A]	THR
1	C	349[B]	THR
1	C	349[C]	THR

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Mol	Chain	Res	Type
1	A	544[A]	VAL
1	A	544[B]	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 27 such sidechains are listed below:

Mol	Chain	Res	Type
2	B	193	GLN
1	C	172	GLN
1	C	486	GLN
1	C	125	HIS
1	C	232	ASN

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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 20 ligands modelled in this entry, 6 are monoatomic - leaving 14 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	$\# Z > 2$
6	GOL	A	605	-	5,5,5	0.60	0	5,5,5	0.71	0
8	SF3	B	301[B]	2	0,8,8	-	-	-		

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
6	GOL	C	705	-	5,5,5	0.41	0	5,5,5	0.42	0
6	GOL	C	706	-	5,5,5	0.59	0	5,5,5	0.72	0
9	F3S	D	302	2	0,9,9	-	-	-		
10	SF4	B	303	2	0,12,12	-	-	-		
10	SF4	D	303	2	0,12,12	-	-	-		
8	SF3	D	301[A]	2	0,8,8	-	-	-		
4	FCO	C	703	5,1	0,6,6	-	-	-		
9	F3S	B	302	2	0,9,9	-	-	-		
6	GOL	A	604	-	5,5,5	0.35	0	5,5,5	0.45	0
8	SF3	D	301[B]	2	0,8,8	-	-	-		
4	FCO	A	602	5,1	0,6,6	-	-	-		
8	SF3	B	301[A]	2	0,8,8	-	-	-		

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
6	GOL	A	605	-	-	0/4/4/4	-
8	SF3	B	301[B]	2	-	-	0/2/2/2
6	GOL	C	705	-	-	0/4/4/4	-
6	GOL	C	706	-	-	0/4/4/4	-
9	F3S	D	302	2	-	-	0/3/3/3
10	SF4	B	303	2	-	-	0/6/5/5
10	SF4	D	303	2	-	-	0/6/5/5
8	SF3	D	301[A]	2	-	-	0/2/2/2
9	F3S	B	302	2	-	-	0/3/3/3
6	GOL	A	604	-	-	0/4/4/4	-
8	SF3	D	301[B]	2	-	-	0/2/2/2
8	SF3	B	301[A]	2	-	-	0/2/2/2

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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, 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	595/596 (99%)	-0.47	2 (0%) 90 93	6, 13, 24, 32	36 (6%)
1	C	595/596 (99%)	-0.35	3 (0%) 87 91	7, 16, 29, 44	26 (4%)
2	B	273/283 (96%)	-0.31	9 (3%) 49 57	4, 13, 30, 49	23 (8%)
2	D	267/283 (94%)	-0.30	4 (1%) 72 78	6, 14, 33, 52	11 (4%)
All	All	1730/1758 (98%)	-0.38	18 (1%) 79 84	4, 14, 28, 52	96 (5%)

The worst 5 of 18 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	283	GLY	4.1
2	B	282	PHE	3.6
1	A	313	TYR	3.6
2	B	281	ALA	3.6
2	D	276	ASP	3.4

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 oligosaccharides 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. 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	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
6	GOL	C	706	6/6	0.88	0.11	21,24,24,27	0
6	GOL	A	605	6/6	0.91	0.10	20,21,24,28	0
6	GOL	C	705	6/6	0.92	0.10	23,25,28,36	0
5	O	C	704	1/1	0.92	0.09	16,16,16,16	0
6	GOL	A	604	6/6	0.94	0.08	21,23,25,31	0
5	O	A	603	1/1	0.96	0.10	14,14,14,14	0
9	F3S	B	302	7/7	0.99	0.02	9,10,10,10	0
4	FCO	C	703	7/7	1.00	0.04	12,12,13,14	0
3	3NI	A	601	1/1	1.00	0.07	15,15,15,15	0
3	3NI	C	702	1/1	1.00	0.09	17,17,17,17	0
7	MG	A	606	1/1	1.00	0.02	10,10,10,10	0
7	MG	C	701	1/1	1.00	0.01	12,12,12,12	0
8	SF3	B	301[A]	7/7	1.00	0.02	10,10,11,11	1
8	SF3	B	301[B]	7/7	1.00	0.02	10,10,11,11	1
8	SF3	D	301[A]	7/7	1.00	0.02	11,12,13,13	1
8	SF3	D	301[B]	7/7	1.00	0.02	11,12,13,13	1
4	FCO	A	602	7/7	1.00	0.03	10,11,12,12	0
9	F3S	D	302	7/7	1.00	0.01	10,10,11,11	0
10	SF4	B	303	8/8	1.00	0.02	10,10,11,11	0
10	SF4	D	303	8/8	1.00	0.01	11,11,12,12	0

6.5 Other polymers [i](#)

There are no such residues in this entry.