Full wwPDB X-ray Structure Validation Report (i)

Sep 26, 2020 – 08:32 AM BST

PDB ID	:	6Z8M
Title	:	Structure of [NiFeSe] hydrogenase G491S variant from Desulfovibrio vulgaris Hildenborough pressurized with Oxygen gas - structure G491S-O2
Authors	:	Zacarias, S.; Temporao, A.; Carpentier, P.; van der Linden, P.; Pereira, I.A.C.; Matias, P.M.
Deposited on	:	2020-06-02
Resolution	:	1.02 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

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

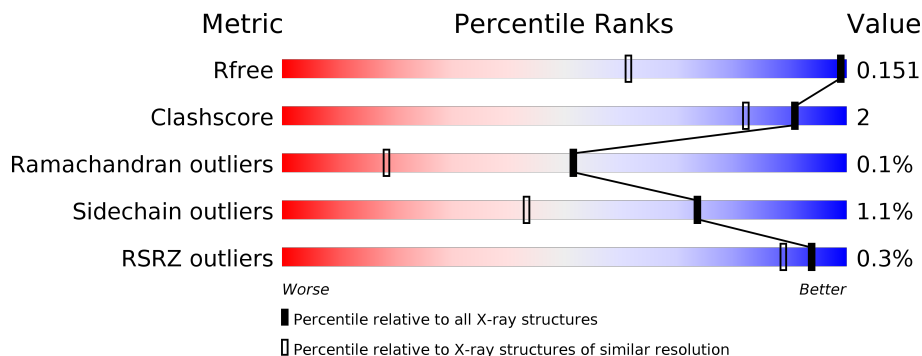|		
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.14.6
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.14.6

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.02 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	Percentile Ranks	Value
Rfree		0.151
Clashscore		2
Ramachandran outliers		0.1%
Sidechain outliers		1.1%
RSRZ outliers		0.3%

■ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	1188 (1.08-0.96)
Clashscore	141614	1253 (1.08-0.96)
Ramachandran outliers	138981	1178 (1.08-0.96)
Sidechain outliers	138945	1180 (1.08-0.96)
RSRZ outliers	127900	1158 (1.08-0.96)

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 >=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% 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	283	97%
2	B	485	95% 5%

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
9	H2S	B	504[B]	-	-	X	-

2 Entry composition (i)

There are 12 unique types of molecules in this entry. The entry contains 12865 atoms, of which 6071 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 Periplasmic [NiFeSe] hydrogenase, small subunit.

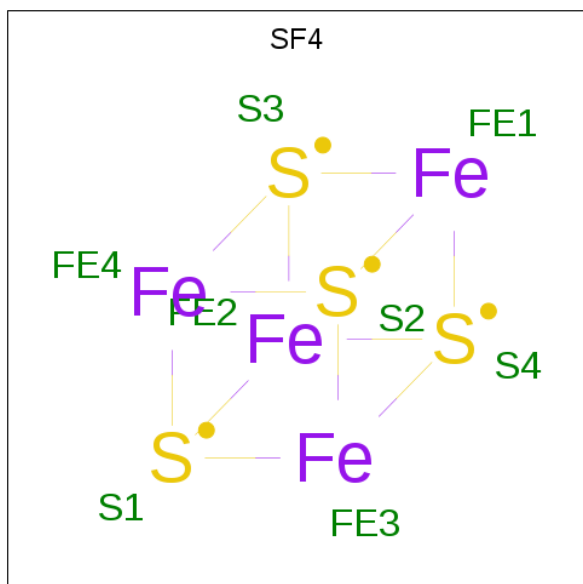| Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	283	Total	C	H	N	O	S	0	17	0
			4378	1411	2179	359	408	21			

- Molecule 2 is a protein called Periplasmic [NiFeSe] hydrogenase, large subunit, selenocysteine-containing.

Mol	Chain	Residues	Atoms							ZeroOcc	AltConf	Trace
2	B	483	Total	C	H	N	O	S	Se	0	14	0
			7679	2440	3860	661	696	19	3			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	491	SER	GLY	engineered mutation	UNP Q72AS3

- Molecule 3 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe_4S_4).

SF4

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total 8	Fe 4	S 4	0	0
3	A	1	Total 8	Fe 4	S 4	0	0
3	A	1	Total 8	Fe 4	S 4	0	1

- Molecule 4 is oxygen-damaged SF4 (three-letter code: 6ML) (formula: $Fe_4O_2S_4$).
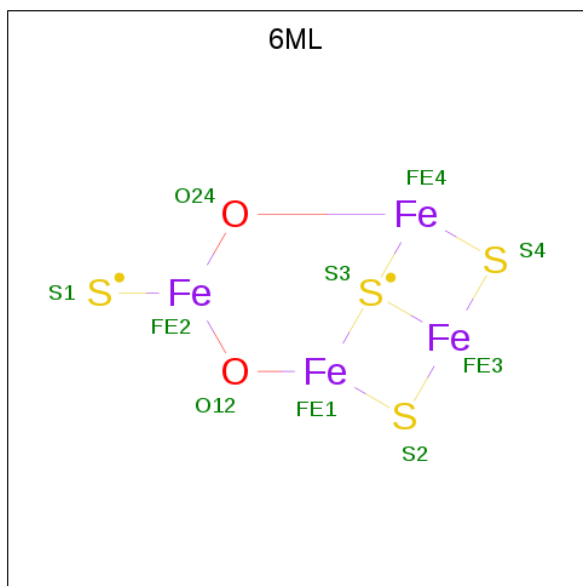
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total 10	Fe 4	O 2	S 4	0	1

- Molecule 5 is GLYCEROL (three-letter code: GOL) (formula: $C_3H_8O_3$).

GOL

C3

OH O3

C1

C2

HO

O1

OH

O2

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total 28	C 6	H 16	O 6	0	1
5	B	1	Total 14	C 3	H 8	O 3	0	0
5	B	1	Total 14	C 3	H 8	O 3	0	0

- Molecule 6 is CARBONMONOXIDE-(DICYANO) IRON (three-letter code: FCO) (formula: C_3FeN_2O).

FCO

O3

O

C

C3

C1

Fe

N N1

FE

C2

N

N2
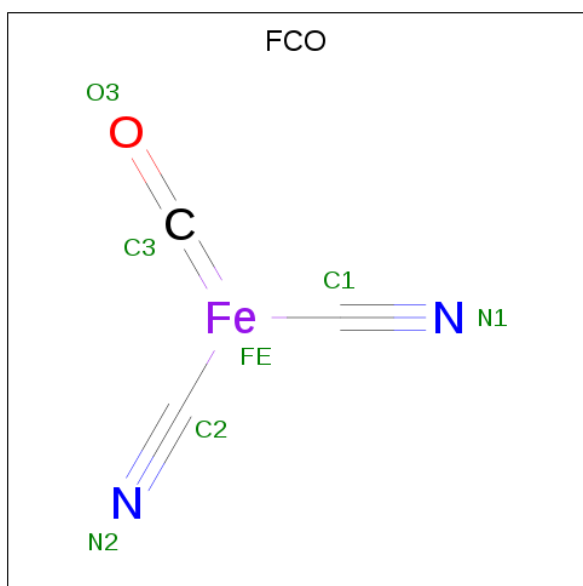
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
6	B	1	Total 7	C 3	Fe 1	N 2	O 1	0	0

- Molecule 7 is NICKEL (II) ION (three-letter code: NI) (formula: Ni).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	B	1	Total 2	Ni 2	0	1

- Molecule 8 is FE (II) ION (three-letter code: FE2) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	B	1	Total 1	Fe 1	0	0

- Molecule 9 is HYDROSULFURIC ACID (three-letter code: H2S) (formula: H_2S).
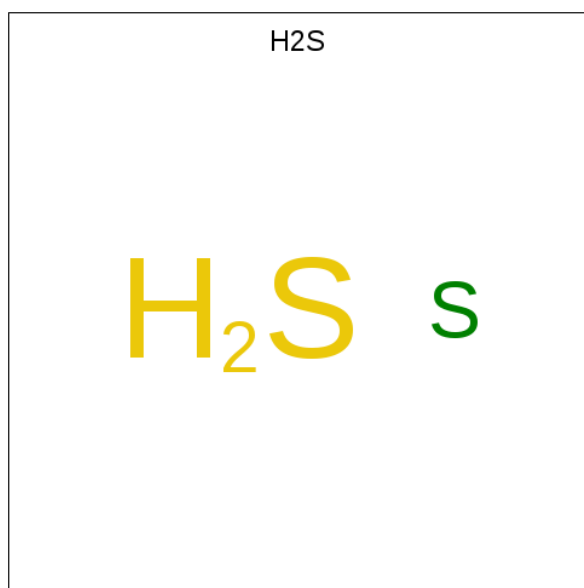
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	B	1	Total 2	S 2	0	1

- Molecule 10 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	B	1	Total 1	Cl 1	0	0

- Molecule 11 is OXYGEN MOLECULE (three-letter code: OXY) (formula: O_2).
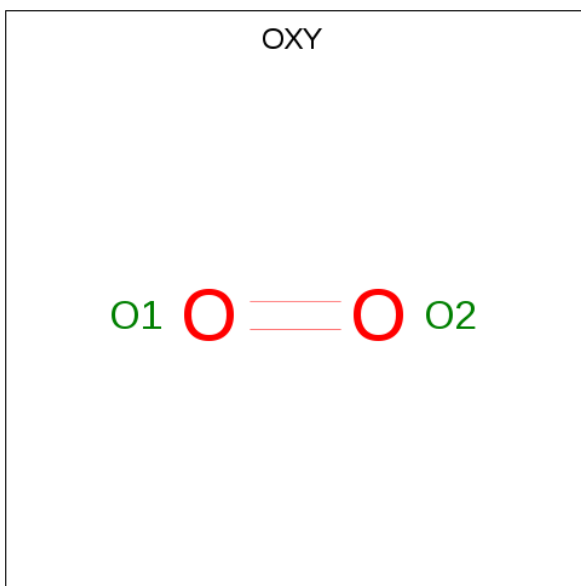
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
11	B	1	Total 2	O 2	0	0
11	B	1	Total 2	O 2	0	0

- Molecule 12 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
12	A	274	Total 283	O 283	0	15
12	B	410	Total 418	O 418	0	12

3 Residue-property plots ⓘ

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: Periplasmic [NiFeSe] hydrogenase, small subunit
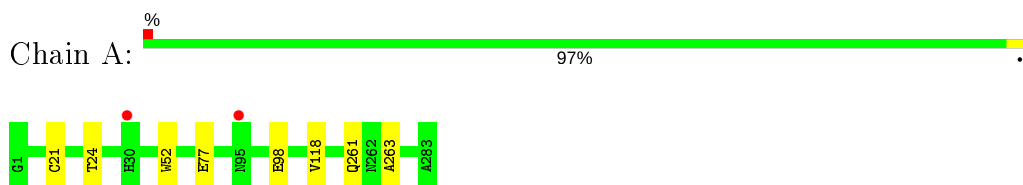
• Molecule 2: Periplasmic [NiFeSe] hydrogenase, large subunit, selenocysteine-containing
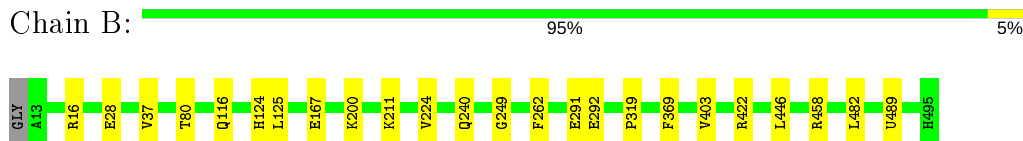
4   Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	105.99Å 62.64Å 110.53Å 90.00° 105.21° 90.00°	Depositor
Resolution (Å)	53.33 – 1.02 53.33 – 1.02	Depositor EDS
% Data completeness (in resolution range)	86.8 (53.33-1.02) 94.5 (53.33-1.02)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$<I/\sigma(I)>$ [1]	1.42 (at 1.02Å)	Xtriage
Refinement program	PHENIX 1.17.1_3660	Depositor
R, R_{free}	0.134 , 0.151 0.135 , 0.151	Depositor DCC
R_{free} test set	16559 reflections (4.99%)	wwPDB-VP
Wilson B-factor (Å^2)	10.5	Xtriage
Anisotropy	0.228	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.43 , 49.1	EDS
L-test for twinning[2]	$<|L|> = 0.50, <L^2> = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.99	EDS
Total number of atoms	12865	wwPDB-VP
Average B, all atoms (Å^2)	14.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.19% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.

[2]Theoretical values of $<|L|>$, $<L^2>$ 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: NI, 6ML, OXY, GOL, CSD, SF4, CL, H2S, SEC, FE2, FCO

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	0.37	0/2309	0.61	0/3137
2	B	0.36	0/3923	0.65	2/5300 (0.0%)
All	All	0.36	0/6232	0.64	2/8437 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	458	ARG	NE-CZ-NH1	5.64	123.12	120.30
2	B	458	ARG	NE-CZ-NH2	-5.01	117.79	120.30

There are no chirality outliers.

There are no planarity outliers.

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	2199	2179	2142	4	0
2	B	3819	3860	3832	15	0
3	A	24	0	0	0	0
4	A	10	0	0	0	0
5	A	12	16	16	1	0
5	B	12	16	15	0	0
6	B	7	0	0	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
7	B	2	0	0	1	0
8	B	1	0	0	0	0
9	B	2	0	0	2	0
10	B	1	0	0	0	0
11	B	4	0	0	0	0
12	A	283	0	0	0	0
12	B	418	0	0	5	0
All	All	6794	6071	6005	20	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 2.

All (20) 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:167:GLU:OE2	12:B:601[A]:HOH:O	1.88	0.92
7:B:502[B]:NI:NI	9:B:504[B]:H2S:S	1.59	0.85
1:A:21[B]:CYS:SG	1:A:118:VAL:HG12	2.21	0.81
2:B:489[A]:SEC:SE	6:B:501:FCO:C1	2.83	0.76
2:B:28:GLU:HB3	2:B:489[A]:SEC:CB	2.29	0.62
2:B:291:GLU:HG3	12:B:890:HOH:O	2.08	0.54
2:B:422:ARG:HD2	9:B:504[B]:H2S:S	2.52	0.50
2:B:200:LYS:HD2	12:B:826:HOH:O	2.11	0.49
2:B:292[B]:GLU:OE2	12:B:602:HOH:O	2.20	0.49
2:B:291:GLU:HG2	12:B:748:HOH:O	2.13	0.48
2:B:249:GLY:HA2	2:B:262:PHE:O	2.15	0.46
1:A:21[B]:CYS:O	1:A:24:THR:HG22	2.16	0.44
1:A:21[B]:CYS:HB2	1:A:77:GLU:OE2	2.17	0.44
2:B:482:LEU:HD13	2:B:482:LEU:C	2.39	0.43
2:B:319:PRO:HG3	2:B:446:LEU:HG	2.01	0.42
2:B:124:HIS:C	2:B:125[B]:LEU:HD12	2.40	0.42
2:B:240:GLN:HA	2:B:369:PHE:O	2.20	0.41
1:A:98:GLU:HG3	5:A:305[B]:GOL:H11	2.03	0.41
2:B:16:ARG:HA	2:B:37:VAL:O	2.22	0.40
2:B:422:ARG:CD	2:B:489[B]:SEC:SE	3.20	0.40

There are no symmetry-related clashes.

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	298/283 (105%)	291 (98%)	6 (2%)	1 (0%)	41	14
2	B	491/485 (101%)	482 (98%)	9 (2%)	0	100	100
All	All	789/768 (103%)	773 (98%)	15 (2%)	1 (0%)	51	18

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	263	ALA

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	242/226 (107%)	240 (99%)	2 (1%)	81	54
2	B	405/393 (103%)	400 (99%)	5 (1%)	71	39
All	All	647/619 (104%)	640 (99%)	7 (1%)	73	43

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

Mol	Chain	Res	Type
1	A	52	TRP
1	A	261	GLN
2	B	80	THR
2	B	116	GLN
2	B	211	LYS

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Mol	Chain	Res	Type
2	B	224	VAL
2	B	403	VAL

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA (i)

There are no RNA molecules in this entry.

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

1 non-standard protein/DNA/RNA residue is 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	CSD	B	75[B]	2,7	3,7,8	1.38	0	1,8,10	1.21	0

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	CSD	B	75[B]	2,7	-	0/2/6/8	-

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.

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 17 ligands modelled in this entry, 4 are monoatomic and 2 are modelled with single atom - leaving 11 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	$\#|Z| > 2$
3	SF4	A	302	1	0,12,12	0.00	-	-		
3	SF4	A	301	1	0,12,12	0.00	-	-		
5	GOL	B	507	-	5,5,5	1.00	0	5,5,5	1.00	0
5	GOL	A	305[B]	-	5,5,5	0.95	0	5,5,5	0.95	0
11	OXY	B	508	-	1,1,1	0.16	0	-		
5	GOL	A	305[A]	-	5,5,5	0.91	0	5,5,5	0.91	0
11	OXY	B	509	-	1,1,1	0.15	0	-		
6	FCO	B	501	9,2	0,6,6	0.00	-	-		
5	GOL	B	506	-	5,5,5	1.20	1 (20%)	5,5,5	0.98	0
3	SF4	A	303[A]	1	0,12,12	0.00	-	-		
4	6ML	A	304[B]	1	0,12,12	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
3	SF4	A	302	1	-	-	0/6/5/5
3	SF4	A	301	1	-	-	0/6/5/5
5	GOL	B	507	-	-	2/4/4/4	-
5	GOL	A	305[B]	-	-	0/4/4/4	-
5	GOL	A	305[A]	-	-	0/4/4/4	-
5	GOL	B	506	-	-	2/4/4/4	-
3	SF4	A	303[A]	1	-	-	0/6/5/5

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	6ML	A	304[B]	1	-	-	0/2/3/3

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	B	506	GOL	O2-C2	-2.29	1.36	1.43

There are no bond angle outliers.

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	B	507	GOL	O1-C1-C2-C3
5	B	506	GOL	C1-C2-C3-O3
5	B	506	GOL	O2-C2-C3-O3
5	B	507	GOL	O1-C1-C2-O2

There are no ring outliers.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	305[B]	GOL	1	0
6	B	501	FCO	1	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, 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(Å²)	Q<0.9
1	A	283/283 (100%)	-0.48	2 (0%)	87	82	8, 11, 21, 34	4 (1%)
2	B	481/485 (99%)	-0.61	0	100	100	8, 11, 19, 31	5 (1%)
All	All	764/768 (99%)	-0.56	2 (0%)	94	89	8, 11, 19, 34	9 (1%)

All (2) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	95	ASN	2.6
1	A	30	HIS	2.4

6.2 Non-standard residues in protein, DNA, RNA chains (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(Å²)	Q<0.9
2	CSD	B	75[B]	8/9	0.99	0.05	8,9,11,11	12

6.3 Carbohydrates (i)

There are no monosaccharides 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(Å^2)	Q<0.9
5	GOL	B	507	6/6	0.73	0.21	32,38,43,45	0
5	GOL	A	305[B]	6/6	0.84	0.15	26,31,33,33	14
5	GOL	A	305[A]	6/6	0.84	0.15	29,34,36,36	14
5	GOL	B	506	6/6	0.91	0.18	17,26,30,32	0
11	OXY	B	509	2/2	0.94	0.17	29,29,29,29	2
11	OXY	B	508	2/2	0.94	0.09	33,33,33,33	0
9	H2S	B	504[B]	1/1	0.99	0.07	10,10,10,10	1
9	H2S	B	504[A]	1/1	0.99	0.07	9,9,9,9	1
3	SF4	A	301	8/8	1.00	0.06	9,9,10,10	0
3	SF4	A	302	8/8	1.00	0.06	8,8,9,9	0
8	FE2	B	503	1/1	1.00	0.04	9,9,9,9	0
6	FCO	B	501	7/7	1.00	0.06	9,10,10,13	0
7	NI	B	502[A]	1/1	1.00	0.05	10,10,10,10	1
10	CL	B	505	1/1	1.00	0.05	8,8,8,8	0
3	SF4	A	303[A]	8/8	1.00	0.06	7,8,8,8	8
4	6ML	A	304[B]	10/10	1.00	0.07	8,9,10,10	10
7	NI	B	502[B]	1/1	1.00	0.05	9,9,9,9	1

6.5 Other polymers (i)

There are no such residues in this entry.