



# wwPDB X-ray Structure Validation Summary Report ⓘ

Nov 6, 2017 – 08:01 AM EST

PDB ID : 4IUB  
Title : Crystal structure of an O<sub>2</sub>-tolerant [NiFe]-hydrogenase from *Ralstonia eutropha* in its as-isolated form - oxidized state 1  
Authors : Frielingsdorf, S.; Schmidt, A.; Fritsch, J.; Lenz, O.; Scheerer, P.  
Deposited on : unknown  
Resolution : 1.61 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 : 1.7.2 (RC1), CSD as538be (2017)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20030345  
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)  
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) : rb-20030345

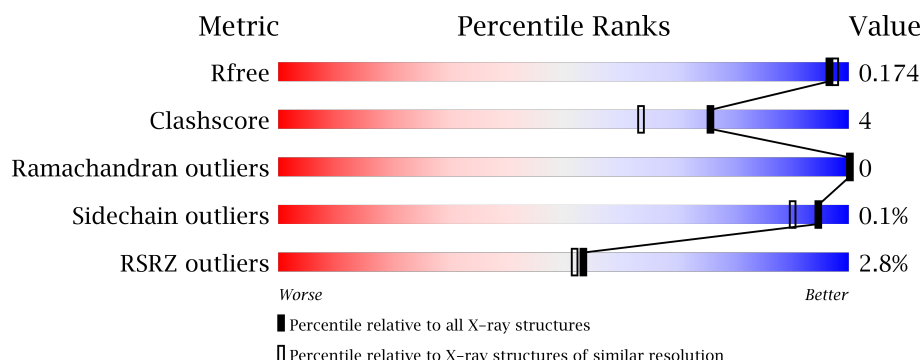
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 1.61 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))
$R_{free}$	100719	3539 (1.64-1.60)
Clashscore	112137	3855 (1.64-1.60)
Ramachandran outliers	110173	3764 (1.64-1.60)
Sidechain outliers	110143	3763 (1.64-1.60)
RSRZ outliers	101464	3562 (1.64-1.60)

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	L	603	<div> <div>3%</div> <div>92%</div> <div>7%</div> </div>
2	S	339	<div> <div>%</div> <div>72%</div> <div>6%</div> <div>22%</div> </div>

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
5	PO4	L	705	-	-	-	X
5	PO4	S	1004	-	-	-	X
9	CL	S	1005	-	-	-	X

## 2 Entry composition

There are 10 unique types of molecules in this entry. The entry contains 7544 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 Uptake hydrogenase large subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	L	602	Total	C	N	O	S	0	8	0
			4770	3025	850	873	22			

- Molecule 2 is a protein called Uptake hydrogenase small subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	S	264	Total	C	N	O	S	0	6	0
			2089	1327	352	389	21			

There are 22 discrepancies between the modelled and reference sequences:

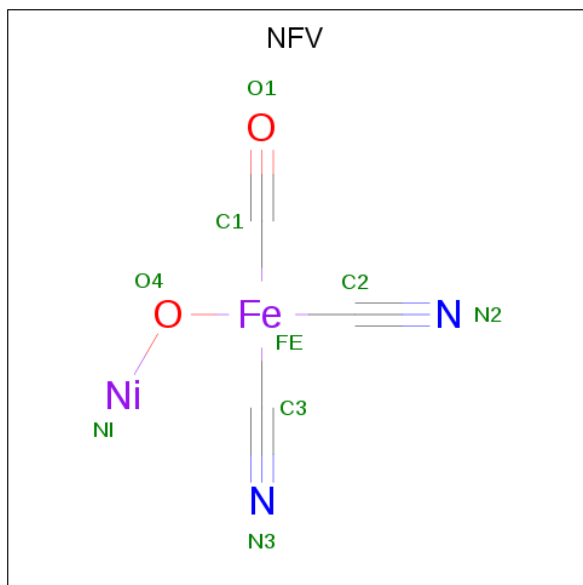
Chain	Residue	Modelled	Actual	Comment	Reference
S	318	ARG	-	EXPRESSION TAG	UNP P31892
S	319	SER	-	EXPRESSION TAG	UNP P31892
S	320	ALA	-	EXPRESSION TAG	UNP P31892
S	321	TRP	-	EXPRESSION TAG	UNP P31892
S	322	SER	-	EXPRESSION TAG	UNP P31892
S	323	HIS	-	EXPRESSION TAG	UNP P31892
S	324	PRO	-	EXPRESSION TAG	UNP P31892
S	325	GLN	-	EXPRESSION TAG	UNP P31892
S	326	PHE	-	EXPRESSION TAG	UNP P31892
S	327	GLU	-	EXPRESSION TAG	UNP P31892
S	328	LYS	-	EXPRESSION TAG	UNP P31892
S	329	ARG	-	EXPRESSION TAG	UNP P31892
S	330	SER	-	EXPRESSION TAG	UNP P31892
S	331	ALA	-	EXPRESSION TAG	UNP P31892
S	332	TRP	-	EXPRESSION TAG	UNP P31892
S	333	SER	-	EXPRESSION TAG	UNP P31892
S	334	HIS	-	EXPRESSION TAG	UNP P31892
S	335	PRO	-	EXPRESSION TAG	UNP P31892
S	336	GLN	-	EXPRESSION TAG	UNP P31892
S	337	PHE	-	EXPRESSION TAG	UNP P31892

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Chain	Residue	Modelled	Actual	Comment	Reference
S	338	GLU	-	EXPRESSION TAG	UNP P31892
S	339	LYS	-	EXPRESSION TAG	UNP P31892

- Molecule 3 is NI-FE OXIDIZED ACTIVE CENTER (three-letter code: NFV) (formula:  $C_3FeN_2NiO_2$ ).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	L	1	Total	C	Fe	N	Ni	O	
			9	3	1	2	1	2	0

- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	L	1	Total	Mg		
			1	1	0	0

- Molecule 5 is PHOSPHATE ION (three-letter code: PO4) (formula:  $O_4P$ ).



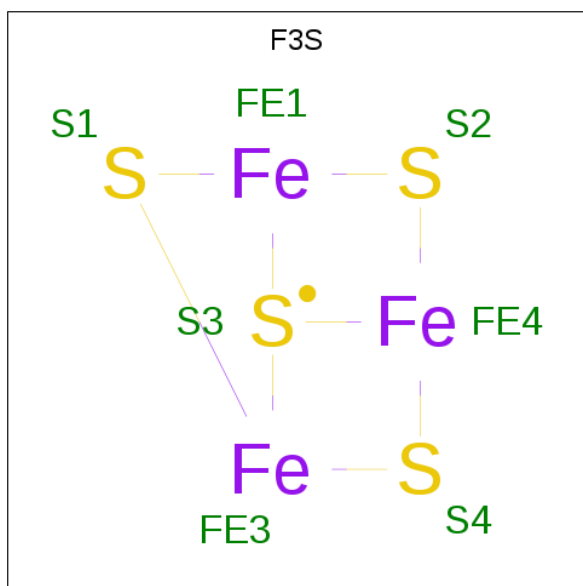
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	L	1	Total	O	P	0	0
			5	4	1		
5	L	1	Total	O	P	0	0
			5	4	1		
5	L	1	Total	O	P	0	0
			5	4	1		
5	L	1	Total	O	P	0	0
			5	4	1		
5	S	1	Total	O	P	0	0
			5	4	1		

- Molecule 6 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe<sub>4</sub>S<sub>4</sub>).



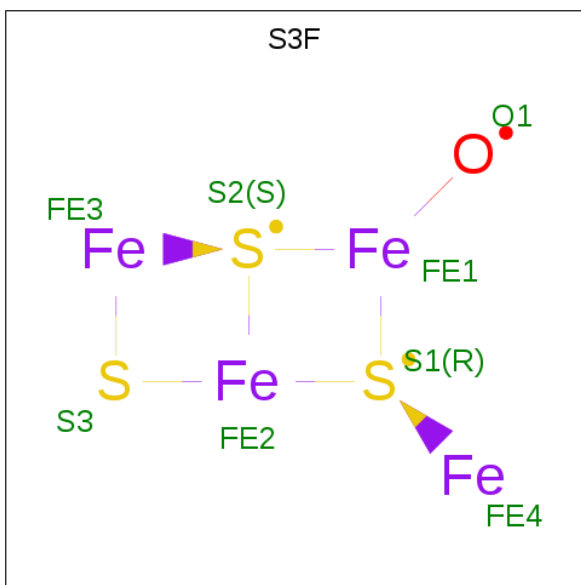
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	S	1	Total	Fe	S	0	0
			8	4	4		

- Molecule 7 is FE3-S4 CLUSTER (three-letter code: F3S) (formula:  $\text{Fe}_3\text{S}_4$ ).



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

- Molecule 8 is oxidized  $[\text{Fe}_4\text{-S}_3]$  cluster (three-letter code: S3F) (formula:  $\text{Fe}_4\text{OS}_3$ ).



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

- Molecule 9 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	S	1	Total	Cl	0	0
			1	1		

- Molecule 10 is water.

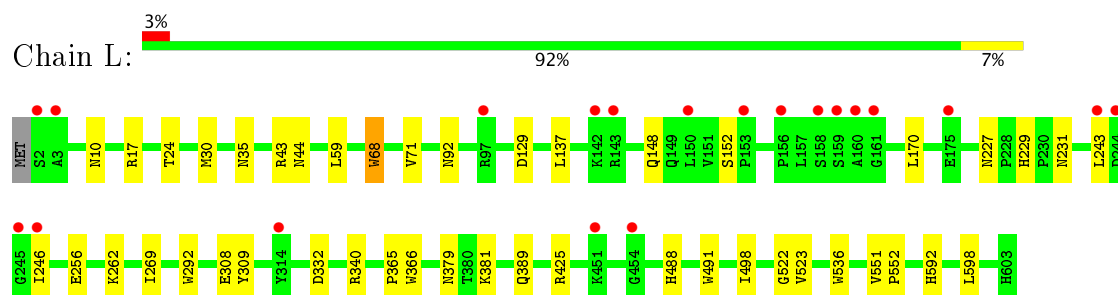
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	L	425	Total	O	0	17
			443	443		
10	S	177	Total	O	0	1
			178	178		



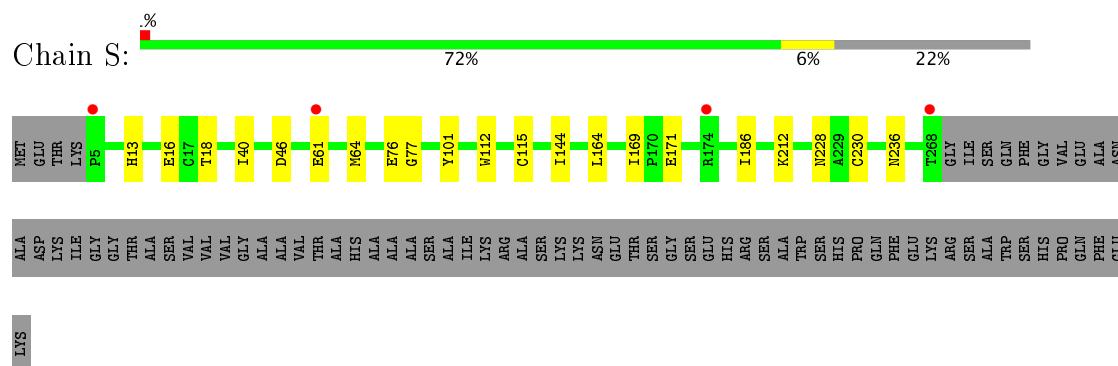
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: Uptake hydrogenase large subunit



- Molecule 2: Uptake hydrogenase small subunit



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	72.90 Å 95.39 Å 118.82 Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	34.05 – 1.61 34.05 – 1.61	Depositor EDS
% Data completeness (in resolution range)	99.8 (34.05-1.61) 99.8 (34.05-1.61)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	0.06	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.93 (at 1.61 Å)	Xtriage
Refinement program	REFMAC 5.6.0117	Depositor
R, $R_{free}$	0.128 , 0.166 0.138 , 0.174	Depositor DCC
$R_{free}$ test set	5374 reflections (5.26%)	DCC
Wilson B-factor (Å <sup>2</sup> )	15.4	Xtriage
Anisotropy	0.131	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.40 , 59.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	7544	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	16.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.51% 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, 0.333 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: MG, CL, PO4, NFV, F3S, S3F, SF4

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	L	0.53	2/4919 (0.0%)	0.55	0/6697
2	S	0.51	1/2163 (0.0%)	0.56	0/2932
All	All	0.52	3/7082 (0.0%)	0.55	0/9629

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	S	112	TRP	CD2-CE2	5.14	1.47	1.41
1	L	366	TRP	CD2-CE2	5.01	1.47	1.41
1	L	68	TRP	CD2-CE2	5.01	1.47	1.41

There are no bond angle outliers.

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	L	4770	0	4695	32	0
2	S	2089	0	2034	19	0
3	L	9	0	0	0	0
4	L	1	0	0	0	0
5	L	25	0	0	0	0
5	S	5	0	0	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	S	8	0	0	0	0
7	S	7	0	0	0	0
8	S	8	0	0	1	0
9	S	1	0	0	0	0
10	L	443	0	0	3	0
10	S	178	0	0	2	0
All	All	7544	0	6729	49	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 49 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:L:17:ARG:HH21	1:L:35:ASN:HD21	1.36	0.73
1:L:129:ASP:OD2	1:L:592:HIS:HD2	1.75	0.69
1:L:227:ASN:H	2:S:236:ASN:HD21	1.44	0.66
1:L:92:ASN:HD22	1:L:523:VAL:H	1.46	0.62
1:L:246[A]:ILE:HD11	2:S:212:LYS:HD3	1.82	0.60

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	L	608/603 (101%)	595 (98%)	13 (2%)	0	100	100
2	S	268/339 (79%)	264 (98%)	4 (2%)	0	100	100
All	All	876/942 (93%)	859 (98%)	17 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 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	L	505/498 (101%)	504 (100%)	1 (0%)	94	90
2	S	229/279 (82%)	229 (100%)	0	100	100
All	All	734/777 (94%)	733 (100%)	1 (0%)	94	90

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	L	292	TRP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such sidechains are listed below:

Mol	Chain	Res	Type
1	L	389	GLN
1	L	446	ASN
1	L	565	GLN
1	L	320	GLN
1	L	519	GLN

### 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 carbohydrates in this entry.

## 5.6 Ligand geometry

Of 12 ligands modelled in this entry, 2 are monoatomic - leaving 10 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	NFV	L	701	1	3,8,8	0.49	0	0,10,10	0.00	-
5	PO4	L	703	-	4,4,4	0.94	0	6,6,6	0.24	0
5	PO4	L	704	-	4,4,4	0.84	0	6,6,6	0.47	0
5	PO4	L	705	-	4,4,4	0.75	0	6,6,6	0.37	0
5	PO4	L	706	-	4,4,4	0.76	0	6,6,6	0.47	0
5	PO4	L	707	-	4,4,4	0.80	0	6,6,6	0.39	0
6	SF4	S	1001	2	0,12,12	0.00	-	0,24,24	0.00	-
7	F3S	S	1002	2	0,9,9	0.00	-	0,15,15	0.00	-
8	S3F	S	1003	2	0,9,9	0.00	-	0,14,14	0.00	-
5	PO4	S	1004	-	4,4,4	0.78	0	6,6,6	0.43	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
3	NFV	L	701	1	-	0/0/12/12	0/0/0/0
5	PO4	L	703	-	-	0/0/0/0	0/0/0/0
5	PO4	L	704	-	-	0/0/0/0	0/0/0/0
5	PO4	L	705	-	-	0/0/0/0	0/0/0/0
5	PO4	L	706	-	-	0/0/0/0	0/0/0/0
5	PO4	L	707	-	-	0/0/0/0	0/0/0/0
6	SF4	S	1001	2	-	0/0/48/48	0/6/5/5
7	F3S	S	1002	2	-	0/0/24/24	0/0/3/3
8	S3F	S	1003	2	-	0/0/21/21	0/2/2/2
5	PO4	S	1004	-	-	0/0/0/0	0/0/0/0

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.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
8	S	1003	S3F	1	0
5	S	1004	PO4	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, 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	L	602/603 (99%)	-0.15	20 (3%) 47 44	8, 13, 29, 42	1 (0%)
2	S	264/339 (77%)	-0.35	4 (1%) 74 74	9, 14, 24, 37	0
All	All	866/942 (91%)	-0.21	24 (2%) 53 52	8, 14, 28, 42	1 (0%)

The worst 5 of 24 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	L	314	TYR	6.3
1	L	246[A]	ILE	5.4
1	L	2	SER	5.0
1	L	150	LEU	3.9
1	L	143	ARG	3.7

### 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( $\text{\AA}^2$ )	Q<0.9
9	CL	S	1005	1/1	0.99	0.19	7.68	15,15,15,15	1
5	PO4	L	705	5/5	0.89	0.13	5.70	16,21,23,26	5
5	PO4	S	1004	5/5	0.84	0.16	2.11	20,26,26,28	5
4	MG	L	702	1/1	0.99	0.08	0.40	8,8,8,8	0
5	PO4	L	703	5/5	0.99	0.07	-0.47	16,16,22,23	0
5	PO4	L	706	5/5	0.96	0.14	-0.60	25,26,29,30	5
7	F3S	S	1002	7/7	0.99	0.06	-0.61	9,9,9,10	0
6	SF4	S	1001	8/8	1.00	0.03	-1.64	10,10,11,11	0
8	S3F	S	1003	8/8	0.99	0.07	-1.96	5,6,10,13	1
3	NFV	L	701	9/9	1.00	0.05	-2.47	7,8,10,10	0
5	PO4	L	704	5/5	0.99	0.07	-	23,24,27,30	0
5	PO4	L	707	5/5	0.94	0.32	-	29,40,44,47	5

## 6.5 Other polymers [i](#)

There are no such residues in this entry.