



# Full wwPDB X-ray Structure Validation Report ⓘ

Apr 8, 2024 – 10:27 AM JST

PDB ID : 8X9D  
Title : Crystal structure of CO dehydrogenase mutant with increased affinity for electron mediators in high PEG concentration  
Authors : Lee, H.H.; Heo, Y.; Yoon, H.J.; Kim, S.M.; Kong, S.Y.  
Deposited on : 2023-11-30  
Resolution : 2.11 Å(reported)

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We welcome your comments at [validation@mail.wwpdb.org](mailto:validation@mail.wwpdb.org)

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<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>.

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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 : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.36  
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) : 2.36

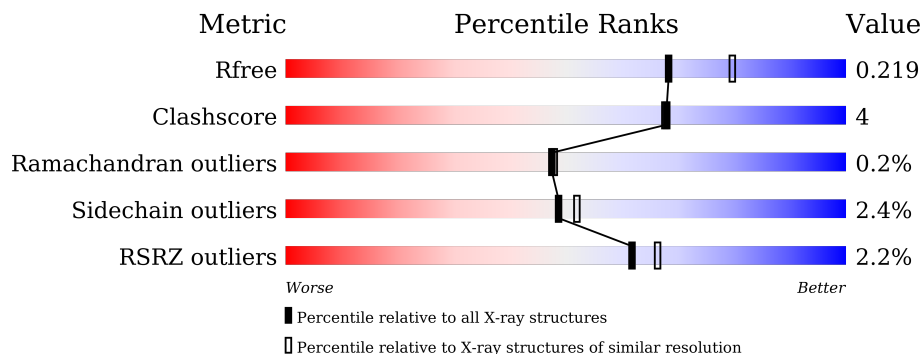
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.11 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))
$R_{free}$	130704	6241 (2.14-2.10)
Clashscore	141614	6778 (2.14-2.10)
Ramachandran outliers	138981	6705 (2.14-2.10)
Sidechain outliers	138945	6706 (2.14-2.10)
RSRZ outliers	127900	6112 (2.14-2.10)

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  $\geq 3$ , 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	656	

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
4	XCC	A	703	-	-	X	-
6	1PE	A	705	-	-	X	-

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 5047 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.

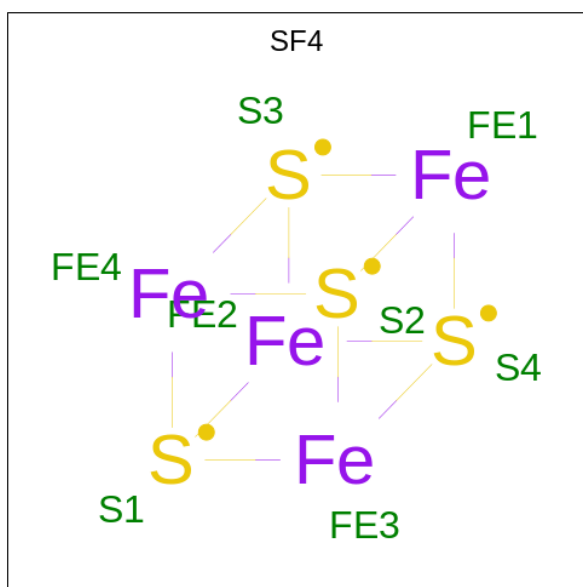
- Molecule 1 is a protein called Carbon monoxide dehydrogenase 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	633	4682	2936	830	878	38	0	7	0

There are 22 discrepancies between the modelled and reference sequences:

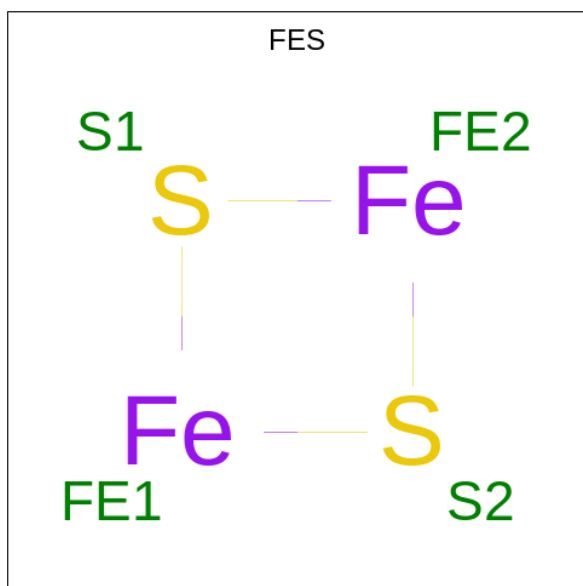
Chain	Residue	Modelled	Actual	Comment	Reference
A	-19	MET	-	initiating methionine	UNP Q9F8A8
A	-18	GLY	-	expression tag	UNP Q9F8A8
A	-17	SER	-	expression tag	UNP Q9F8A8
A	-16	SER	-	expression tag	UNP Q9F8A8
A	-15	HIS	-	expression tag	UNP Q9F8A8
A	-14	HIS	-	expression tag	UNP Q9F8A8
A	-13	HIS	-	expression tag	UNP Q9F8A8
A	-12	HIS	-	expression tag	UNP Q9F8A8
A	-11	HIS	-	expression tag	UNP Q9F8A8
A	-10	HIS	-	expression tag	UNP Q9F8A8
A	-9	SER	-	expression tag	UNP Q9F8A8
A	-8	SER	-	expression tag	UNP Q9F8A8
A	-7	GLY	-	expression tag	UNP Q9F8A8
A	-6	LEU	-	expression tag	UNP Q9F8A8
A	-5	VAL	-	expression tag	UNP Q9F8A8
A	-4	PRO	-	expression tag	UNP Q9F8A8
A	-3	ARG	-	expression tag	UNP Q9F8A8
A	-2	GLY	-	expression tag	UNP Q9F8A8
A	-1	SER	-	expression tag	UNP Q9F8A8
A	0	HIS	-	expression tag	UNP Q9F8A8
A	57	GLY	ARG	engineered mutation	UNP Q9F8A8
A	59	LEU	ASN	engineered mutation	UNP Q9F8A8

- Molecule 2 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe<sub>4</sub>S<sub>4</sub>).



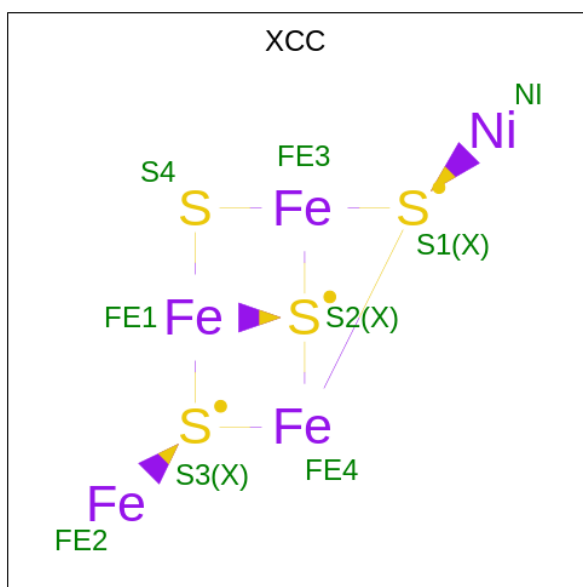
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	Fe	S	0	0
			8	4	4		

- Molecule 3 is FE2/S2 (INORGANIC) CLUSTER (three-letter code: FES) (formula:  $\text{Fe}_2\text{S}_2$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	Fe	S	0	0
			4	2	2		

- Molecule 4 is FE(4)-NI(1)-S(4) CLUSTER (three-letter code: XCC) (formula:  $\text{Fe}_4\text{NiS}_4$ ).

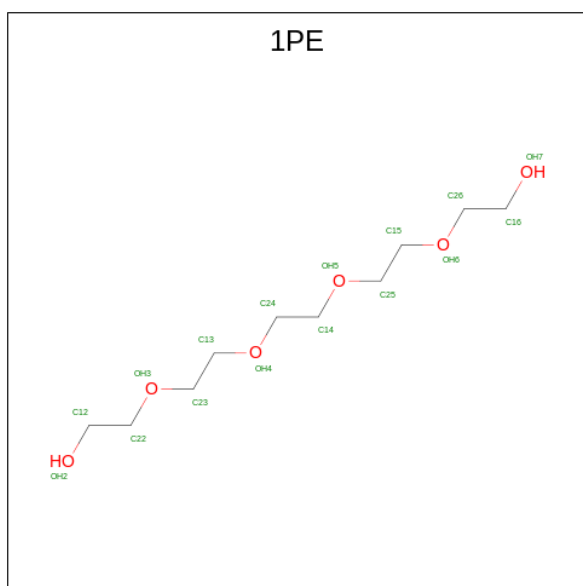


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	Fe	Ni	S		
4	A	1	9	4	1	4	0	0

- Molecule 5 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Fe		
5	A	1	1	1	0	0

- Molecule 6 is PENTAETHYLENE GLYCOL (three-letter code: 1PE) (formula: C<sub>10</sub>H<sub>22</sub>O<sub>6</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			16	10	6		

- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	327	Total	O	0	0
			327	327		



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	112.05Å 74.55Å 71.31Å 90.00° 111.53° 90.00°	Depositor
Resolution (Å)	33.02 – 2.11 33.02 – 2.11	Depositor EDS
% Data completeness (in resolution range)	97.2 (33.02-2.11) 97.2 (33.02-2.11)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.34 (at 2.10Å)	Xtrriage
Refinement program	PHENIX (1.20.1_4487: ???)	Depositor
R, $R_{free}$	0.165 , 0.219 0.167 , 0.219	Depositor DCC
$R_{free}$ test set	1492 reflections (4.85%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	25.2	Xtrriage
Anisotropy	0.066	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.37 , 52.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	5047	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	29.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.17% 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: XCC, 1PE, FES, FE, 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	A	0.45	0/4776	0.64	0/6487

There are no bond length outliers.

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	A	4682	0	4798	35	0
2	A	8	0	0	0	0
3	A	4	0	0	0	0
4	A	9	0	0	2	0
5	A	1	0	0	0	0
6	A	16	0	22	6	2
7	A	327	0	0	1	0
All	All	5047	0	4820	36	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 4.

All (36) 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:526[B]:CYS:SG	7:A:829:HOH:O	2.31	0.88
1:A:446:CYS:HB3	4:A:703:XCC:S2	2.24	0.77
1:A:466:LYS:N	1:A:466:LYS:HD3	2.07	0.68
1:A:261:HIS:HE1	4:A:703:XCC:S3	2.13	0.66
1:A:60:PRO:HG2	6:A:705:1PE:H121	1.79	0.64
1:A:39:CYS:HA	6:A:705:1PE:H141	1.83	0.61
1:A:40:GLY:H	6:A:705:1PE:H132	1.66	0.60
1:A:466:LYS:HD2	1:A:495:LEU:O	2.04	0.58
1:A:392:LYS:HG3	1:A:393:PRO:HD2	1.87	0.57
1:A:312:SER:HB2	1:A:476:CYS:SG	2.46	0.56
1:A:466:LYS:HD3	1:A:466:LYS:H	1.70	0.55
1:A:259:HIS:HE1	1:A:315:GLN:OE1	1.90	0.55
1:A:124:HIS:O	1:A:128:LYS:HG3	2.08	0.53
1:A:40:GLY:N	6:A:705:1PE:H132	2.25	0.51
1:A:40:GLY:H	6:A:705:1PE:H241	1.77	0.50
1:A:446:CYS:HA	1:A:476:CYS:HB2	1.94	0.50
1:A:583:LEU:HD11	1:A:587:THR:HG21	1.92	0.50
1:A:239:PRO:HA	1:A:405:ALA:O	2.12	0.49
1:A:265[B]:LEU:HD23	1:A:265[B]:LEU:H	1.77	0.49
1:A:169:PRO:HB3	1:A:541:ASN:HD21	1.78	0.48
1:A:4:GLN:OE1	1:A:4:GLN:HA	2.14	0.48
1:A:331:TYR:CD2	1:A:353:MET:HG3	2.48	0.47
6:A:705:1PE:H141	6:A:705:1PE:H151	1.53	0.47
1:A:265[A]:LEU:HD13	1:A:366:PHE:CE2	2.50	0.47
1:A:164:VAL:HG23	1:A:221:ALA:HB2	1.97	0.47
1:A:90:ALA:O	1:A:94:SER:HB3	2.15	0.46
1:A:273:SER:HB2	1:A:288:ILE:HG21	1.99	0.44
1:A:462:ARG:O	1:A:466:LYS:HD3	2.18	0.44
1:A:85:SER:HB2	1:A:562:GLU:HG2	2.00	0.43
1:A:265[A]:LEU:HD13	1:A:366:PHE:CD2	2.55	0.42
1:A:504:LEU:HD22	1:A:517:LEU:HB2	2.02	0.42
1:A:424:PRO:O	1:A:427:PRO:HD2	2.20	0.41
1:A:456:ASN:HB2	1:A:558:GLU:HG2	2.03	0.41
1:A:99[A]:HIS:NE2	1:A:264:VAL:HG11	2.36	0.41
1:A:114:SER:OG	1:A:372:VAL:HG23	2.21	0.40
1:A:462:ARG:HA	1:A:466:LYS:HZ3	1.87	0.40

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)
6:A:705:1PE:C16	6:A:705:1PE:OH7[2_555]	1.40	0.80

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
6:A:705:1PE:C16	6:A:705:1PE:C16[2_555]	2.03	0.17

## 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	638/656 (97%)	616 (97%)	21 (3%)	1 (0%)	47 48

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	332	GLN

### 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	502/514 (98%)	489 (97%)	13 (3%)	46 49

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	51	CYS
1	A	94	SER
1	A	224	TYR
1	A	252[A]	ASP

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Mol	Chain	Res	Type
1	A	252[B]	ASP
1	A	267	ASP
1	A	276	MET
1	A	330	ASP
1	A	355	MET
1	A	446	CYS
1	A	462	ARG
1	A	487	MET
1	A	570	TRP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	124	HIS
1	A	259	HIS
1	A	541	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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 5 ligands modelled in this entry, 1 is monoatomic - 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
6	1PE	A	705	-	15,15,15	0.50	0	14,14,14	0.35	0
4	XCC	A	703	1,5	0,11,11	-	-	-		
2	SF4	A	701	1	0,12,12	-	-	-		
3	FES	A	702	1	0,4,4	-	-	-		

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	1PE	A	705	-	-	8/13/13/13	-
4	XCC	A	703	1,5	-	-	0/3/3/3
2	SF4	A	701	1	-	-	0/6/5/5
3	FES	A	702	1	-	-	0/1/1/1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (8) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	705	1PE	C15-C25-OH5-C14
6	A	705	1PE	OH6-C15-C25-OH5
6	A	705	1PE	OH4-C13-C23-OH3
6	A	705	1PE	OH2-C12-C22-OH3
6	A	705	1PE	C13-C23-OH3-C22
6	A	705	1PE	C24-C14-OH5-C25
6	A	705	1PE	C23-C13-OH4-C24
6	A	705	1PE	C14-C24-OH4-C13

There are no ring outliers.

2 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	A	705	1PE	6	2
4	A	703	XCC	2	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	633/656 (96%)	-0.21	14 (2%) 62 66	18, 26, 45, 76	0

All (14) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	513	LEU	3.4
1	A	5	ASN	3.4
1	A	6	LEU	2.9
1	A	294[A]	CYS	2.8
1	A	136	GLY	2.6
1	A	354	GLU	2.4
1	A	355	MET	2.4
1	A	265[A]	LEU	2.4
1	A	138	LYS	2.3
1	A	390	LYS	2.2
1	A	135	GLU	2.1
1	A	137	GLN	2.0
1	A	514	GLY	2.0
1	A	391	GLY	2.0

### 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 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, 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	B-factors(Å <sup>2</sup> )	Q<0.9
6	1PE	A	705	16/16	0.80	0.16	48,48,49,50	1
4	XCC	A	703	9/9	0.83	0.12	25,26,28,28	9
5	FE	A	704	1/1	0.97	0.07	27,27,27,27	1
3	FES	A	702	4/4	0.98	0.05	17,23,25,25	0
2	SF4	A	701	8/8	0.99	0.06	16,18,19,20	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.