



# wwPDB X-ray Structure Validation Summary Report

Mar 28, 2014 – 12:47 AM EDT

PDB ID : 4F6T  
Title : The crystal structure of the molybdenum storage protein (MoSto) from Azotobacter vinelandii loaded with various polyoxometalates  
Authors : Kowalewski, B.; Poppe, J.; Schneider, K.; Demmer, U.; Warkentin, E.; Ermler, U.  
Deposited on : 2012-05-15  
Resolution : 1.60 Å(reported)

This is a wwPDB 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/ValidationPDFNotes.html>

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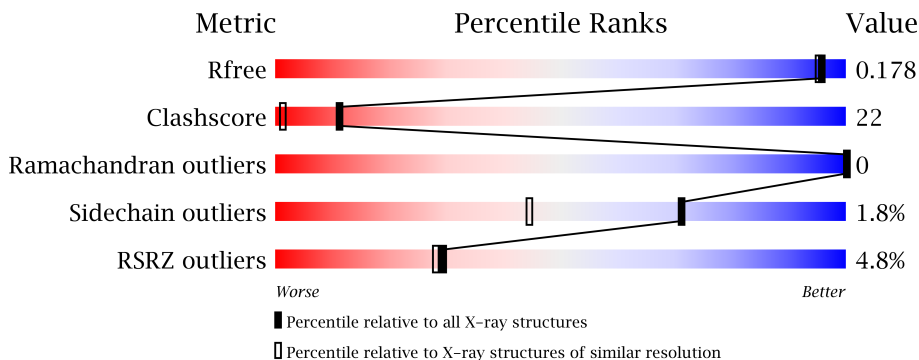
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : dev-1439  
EDS : stable22978  
Percentile statistics : 21963  
Refmac : 5.8.0049  
CCP4 : 6.3.0 (Settle)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : stable22978

# 1 Overall quality at a glance

The reported resolution of this entry is 1.60 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))
$R_{free}$	66092	1872 (1.60-1.60)
Clashscore	79885	2199 (1.60-1.60)
Ramachandran outliers	78287	2126 (1.60-1.60)
Sidechain outliers	78261	2125 (1.60-1.60)
RSRZ outliers	66119	1872 (1.60-1.60)

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. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	B	268	
2	A	244	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
5	PO4	A	305	-	X
7	6M0	B	305	-	X

## 2 Entry composition i

There are 9 unique types of molecules in this entry. The entry contains 4609 atoms, of which 0 are hydrogen and 0 are deuterium.

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.

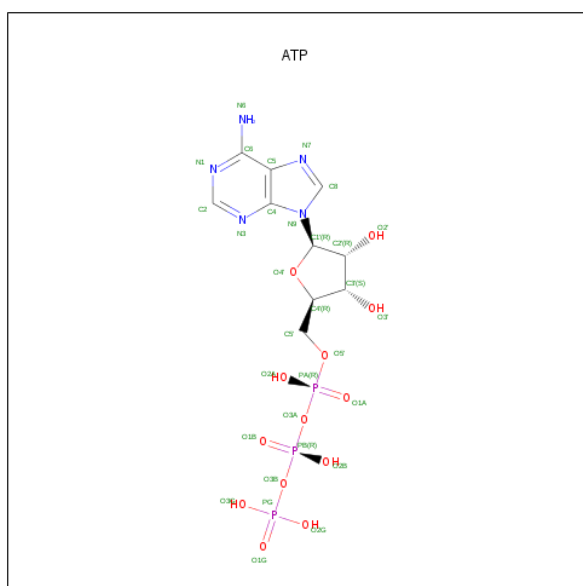
- Molecule 1 is a protein called Molybdenum storage protein subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	B	268	2045	1304	359	374	8	0	13	0

- Molecule 2 is a protein called Molybdenum storage protein subunit alpha.

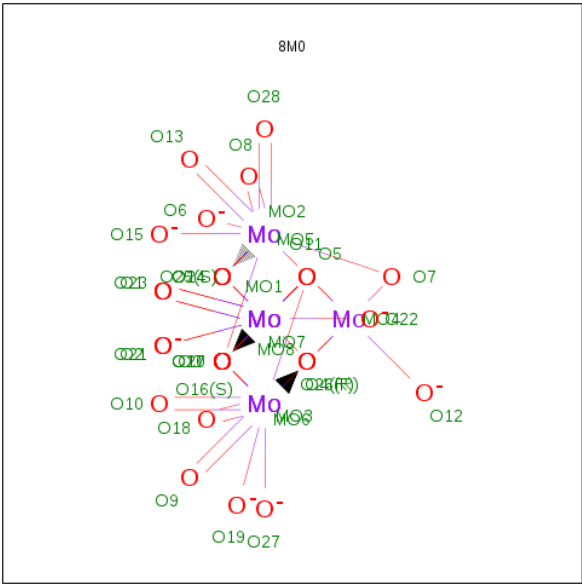
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	A	244	1867	1185	349	330	3	0	8	0

- Molecule 3 is ADENOSINE-5'-TRIPHOSPHATE (three-letter code: ATP) (formula:  $C_{10}H_{16}N_5O_{13}P_3$ ).



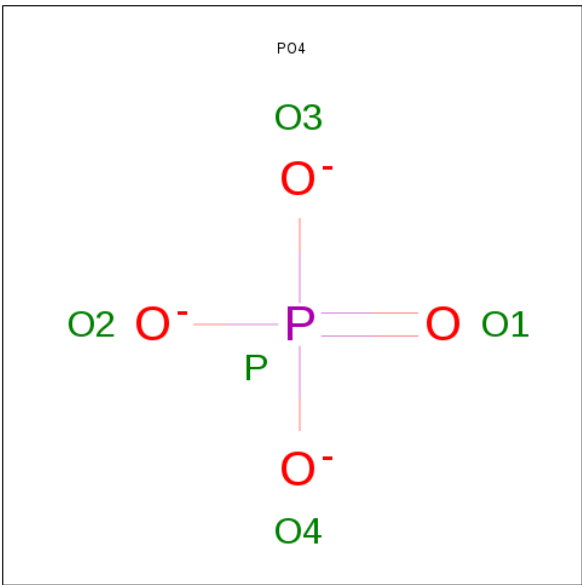
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
3	B	1	31	10	5	13	3	0	0
3	A	1	31	10	5	13	3	0	0

- Molecule 4 is BIS(MU4-OXO)-TETRAKIS(MU3-OXO)-HEXAKIS(MU2-OXO)-HEXADECAOXO-OCTAMOLYBDENUM(VI) (three-letter code: 8M0) (formula: Mo<sub>8</sub>O<sub>28</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	B	1	Total	Mo	O	0	0
			36	8	28		
4	A	1	Total	Mo	O	0	0
			34	8	26		

- Molecule 5 is PHOSPHATE ION (three-letter code: PO4) (formula: O<sub>4</sub>P).

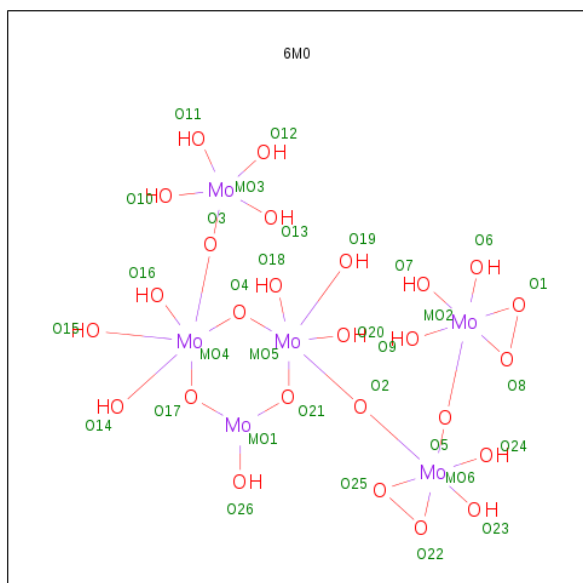


Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	B	1	Total O P 5 4 1	0	0
5	A	1	Total P 1 1	0	0

- Molecule 6 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	B	1	Total Mg 1 1	0	0
6	A	1	Total Mg 1 1	0	0

- Molecule 7 is MO(6)-O(26) CLUSTER (three-letter code: 6M0) (formula:  $\text{H}_{16}\text{Mo}_6\text{O}_{26}$ ).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	B	1	Total Mo O 31 6 25	0	0

- Molecule 8 is MOLYBDENUM ATOM (three-letter code: MO) (formula: Mo).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	A	1	Total Mo 1 1	0	0

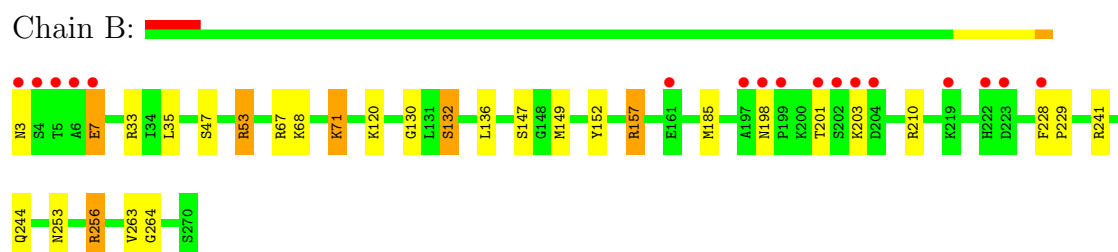
- Molecule 9 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	B	278	Total 278	O 278	0	0
9	A	246	Total 247	O 247	0	1

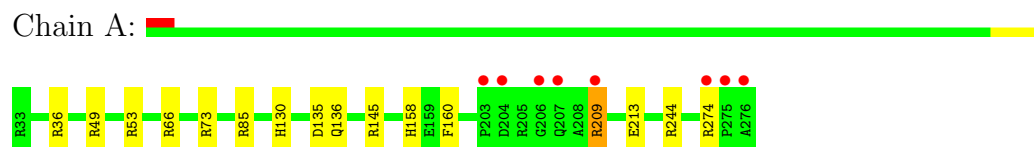
### 3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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: Molybdenum storage protein subunit beta



- Molecule 2: Molybdenum storage protein subunit alpha



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 63 2 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	115.74Å 115.74Å 233.62Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	46.00 – 1.60 46.06 – 1.60	Depositor EDS
% Data completeness (in resolution range)	90.0 (46.00-1.60) 90.0 (46.06-1.60)	Depositor EDS
$R_{merge}$	0.09	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.44 (at 1.60Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, $R_{free}$	0.139 , 0.173 0.145 , 0.178	Depositor DCC
$R_{free}$ test set	5467 reflections (5.25%)	DCC
Wilson B-factor (Å <sup>2</sup> )	14.2	Xtriage
Anisotropy	0.355	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.40 , 45.7	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	0 of 109551 reflections	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	4609	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.81% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.



## 5 Model quality ⓘ

### 5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: MG, PO4, ATP, 8M0, MO, 6M0

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	B	1.36	8/2121 (0.4%)	1.12	12/2878 (0.4%)
2	A	1.35	2/1931 (0.1%)	1.06	8/2630 (0.3%)
All	All	1.35	10/4052 (0.2%)	1.09	20/5508 (0.4%)

The worst 5 of 10 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	47	SER	CB-OG	-9.58	1.29	1.42
1	B	152	TYR	CE1-CZ	6.37	1.46	1.38
1	B	7	GLU	CG-CD	6.07	1.61	1.51
2	A	213	GLU	CD-OE1	5.89	1.32	1.25
1	B	132[A]	SER	C-O	5.78	1.34	1.23

The worst 5 of 20 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	33	ARG	NE-CZ-NH2	-12.99	113.80	120.30
1	B	33	ARG	NE-CZ-NH1	8.95	124.77	120.30
2	A	49	ARG	NE-CZ-NH2	-8.80	115.90	120.30
1	B	53	ARG	NE-CZ-NH2	-8.47	116.06	120.30
1	B	53	ARG	NE-CZ-NH1	8.41	124.50	120.30

There are no chirality outliers.

There are no planarity outliers.

### 5.2 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 hydrogens

added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	B	2045	0	0	18	1
2	A	1867	0	0	11	1
3	A	31	0	0	0	0
3	B	31	0	0	1	0
4	A	34	0	0	1	0
4	B	36	0	0	2	0
5	A	1	0	0	0	0
5	B	5	0	0	0	0
6	A	1	0	0	0	0
6	B	1	0	0	0	0
7	B	31	0	0	60	0
8	A	1	0	0	0	0
9	A	247	0	0	9	1
9	B	278	0	0	17	2
All	All	4609	0	0	90	3

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 22.

The worst 5 of 90 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
7:B:305:6M0:O8	7:B:305:6M0:O1	1.75	1.04
7:B:305:6M0:MO5	7:B:305:6M0:O20	1.28	1.03
7:B:305:6M0:MO4	7:B:305:6M0:O15	1.27	1.01
7:B:305:6M0:O17	7:B:305:6M0:MO4	1.30	1.00
7:B:305:6M0:O25	7:B:305:6M0:O22	1.80	0.99

All (3) 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	Distance(Å)	Clash(Å)
1:B:120[B]:LYS:NZ	9:B:446:HOH:O[2_655]	1.78	0.42
2:A:136[B]:GLN:NE2	9:A:639:HOH:O[2_655]	1.78	0.42
9:B:652:HOH:O	9:B:652:HOH:O[8_555]	2.14	0.06

## 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	B	279/268 (104%)	272 (98%)	7 (2%)	0	100	100
2	A	250/244 (102%)	245 (98%)	5 (2%)	0	100	100
All	All	529/512 (103%)	517 (98%)	12 (2%)	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	B	218/205 (106%)	213 (98%)	5 (2%)	63	32
2	A	195/187 (104%)	192 (98%)	3 (2%)	76	53
All	All	413/392 (105%)	405 (98%)	8 (2%)	71	42

5 of 8 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	203	LYS
2	A	274	ARG
2	A	209[A]	ARG
1	B	198	ASN
1	B	253	ASN

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

### 5.3.3 RNA ⓘ

There are no RNA chains in this entry.

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

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

## 5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

Of 10 ligands modelled in this entry, 1 is modelled with single atom and 3 are monoatomic - leaving 6 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	ATP	A	301	6	33,33,33	1.21	5 (15%)	52,52,52	2.26	8 (15%)
4	8M0	A	303	2,5	45,46,48	5.86	17 (37%)	0,140,150	0.00	-
3	ATP	B	301	-	33,33,33	0.94	1 (3%)	52,52,52	1.94	11 (21%)
4	8M0	B	302	6	48,48,48	6.25	20 (41%)	0,150,150	0.00	-
5	PO4	B	303	-	4,4,4	0.47	0	6,6,6	0.32	0
7	6M0	B	305	-	26,33,34	14.41	18 (69%)	0,81,83	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	ATP	A	301	6	-	0/22/38/38	0/1/3/3
4	8M0	A	303	2,5	-	0/0/290/300	0/0/13/13

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	ATP	B	301	-	-	0/22/38/38	0/1/3/3
4	8M0	B	302	6	-	0/0/300/300	0/0/13/13
5	PO4	B	303	-	-	0/0/0/0	0/0/0/0
7	6M0	B	305	-	-	0/0/67/69	0/1/3/3

The worst 5 of 61 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
7	B	305	6M0	O12-MO3	-38.86	1.33	1.65
7	B	305	6M0	O13-MO3	-38.06	1.34	1.65
7	B	305	6M0	O10-MO3	31.28	1.90	1.65
7	B	305	6M0	O11-MO3	25.12	1.85	1.65
4	A	303	8M0	O20-MO8	24.49	1.96	1.74

The worst 5 of 19 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	301	ATP	N3-C2-N1	-9.30	120.94	128.71
3	A	301	ATP	O4'-C1'-N9	6.85	114.81	108.44
3	B	301	ATP	N3-C2-N1	-6.10	123.61	128.71
3	B	301	ATP	N3-C4-N9	5.60	135.55	125.43
3	B	301	ATP	O4'-C1'-N9	5.01	113.10	108.44

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 5.7 Other polymers ⓘ

There are no such residues in this entry.

## 5.8 Polymer linkage issues

There are no chain breaks in this entry.

## 6 Fit of model and data ⓘ

### 6.1 Protein, DNA and RNA chains ⓘ

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	B	268/268 (100%)	-0.39	17 (6%) 19 19	12, 18, 42, 68	0
2	A	244/244 (100%)	-0.51	8 (3%) 44 42	10, 15, 35, 56	0
All	All	512/512 (100%)	-0.44	25 (4%) 29 27	10, 16, 40, 68	0

The worst 5 of 25 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	3	ASN	7.1
2	A	276	ALA	5.7
1	B	203	LYS	5.1
1	B	222	HIS	4.7
1	B	201	THR	4.2

### 6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

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

### 6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

### 6.4 Ligands ⓘ

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	RSR	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
5	PO4	A	305	1/5	0.29	14.74	69,69,69,69	0
7	6M0	B	305	31/32	0.15	7.10	25,42,74,80	31
5	PO4	B	303	5/5	0.10	1.06	46,47,49,49	0
6	MG	B	304	1/1	0.07	0.99	27,27,27,27	0
4	8M0	B	302	36/36	0.10	0.95	7,12,17,28	34
3	ATP	B	301	31/31	0.10	0.04	11,18,27,29	22
8	MO	A	304	1/1	0.04	-0.38	12,12,12,12	0
4	8M0	A	303	34/36	0.06	-0.65	10,13,15,16	0
3	ATP	A	301	31/31	0.05	-0.67	12,17,20,21	0
6	MG	A	302	1/1	0.02	-3.03	15,15,15,15	0

## 6.5 Other polymers ⓘ

There are no such residues in this entry.