



Full wwPDB X-ray Structure Validation Report ⓘ

May 25, 2020 – 07:17 am BST

PDB ID : 4HAO
Title : Crystal Structure of Inorganic Polyphosphate/ATP-NAD Kinase from *Yersinia pestis* CO92
Authors : Kim, Y.; Maltseva, N.; Jedrzejczak, R.; Anderson, W.F.; Joachimiak, A.; Center for Structural Genomics of Infectious Diseases (CSGID)
Deposited on : 2012-09-27
Resolution : 2.55 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 ⓘ symbol.

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	:	2.11
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)	:	2.11

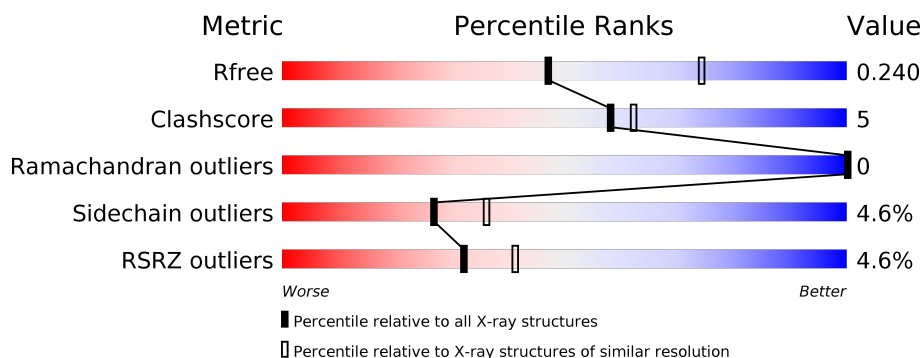
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.55 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	1279 (2.58-2.54)
Clashscore	141614	1327 (2.58-2.54)
Ramachandran outliers	138981	1312 (2.58-2.54)
Sidechain outliers	138945	1312 (2.58-2.54)
RSRZ outliers	127900	1269 (2.58-2.54)

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 $\leq 5\%$. 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	304	<div> <div>5%</div> <div> <div></div> <div>80%</div> <div>13%</div> <div>7%</div> </div> </div>
1	B	304	<div> <div>3%</div> <div> <div></div> <div>80%</div> <div>13%</div> <div>7%</div> </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
2	ACY	B	404	-	-	-	X

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 4553 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 Probable inorganic polyphosphate/ATP-NAD kinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	283	Total	C	N	O	S	0	2	0
			2211	1409	381	415	6			
1	B	284	Total	C	N	O	S	0	3	0
			2236	1423	392	415	6			

There are 22 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	293	GLU	-	EXPRESSION TAG	UNP Q8ZH09
A	294	ASN	-	EXPRESSION TAG	UNP Q8ZH09
A	295	LEU	-	EXPRESSION TAG	UNP Q8ZH09
A	296	TYR	-	EXPRESSION TAG	UNP Q8ZH09
A	297	PHE	-	EXPRESSION TAG	UNP Q8ZH09
A	298	HIS	-	EXPRESSION TAG	UNP Q8ZH09
A	299	HIS	-	EXPRESSION TAG	UNP Q8ZH09
A	300	HIS	-	EXPRESSION TAG	UNP Q8ZH09
A	301	HIS	-	EXPRESSION TAG	UNP Q8ZH09
A	302	HIS	-	EXPRESSION TAG	UNP Q8ZH09
A	303	HIS	-	EXPRESSION TAG	UNP Q8ZH09
B	293	GLU	-	EXPRESSION TAG	UNP Q8ZH09
B	294	ASN	-	EXPRESSION TAG	UNP Q8ZH09
B	295	LEU	-	EXPRESSION TAG	UNP Q8ZH09
B	296	TYR	-	EXPRESSION TAG	UNP Q8ZH09
B	297	PHE	-	EXPRESSION TAG	UNP Q8ZH09
B	298	HIS	-	EXPRESSION TAG	UNP Q8ZH09
B	299	HIS	-	EXPRESSION TAG	UNP Q8ZH09
B	300	HIS	-	EXPRESSION TAG	UNP Q8ZH09
B	301	HIS	-	EXPRESSION TAG	UNP Q8ZH09
B	302	HIS	-	EXPRESSION TAG	UNP Q8ZH09
B	303	HIS	-	EXPRESSION TAG	UNP Q8ZH09

- Molecule 2 is ACETIC ACID (three-letter code: ACY) (formula: C₂H₄O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	A	1	Total	C	O	0	1
			8	4	4		
2	A	1	Total	C	O	0	0
			4	2	2		
2	A	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		
2	B	1	Total	C	O	0	0
			4	2	2		

- Molecule 3 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



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

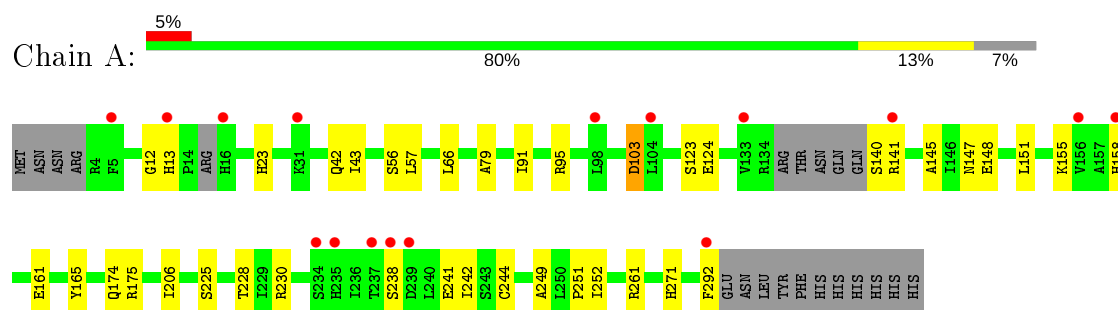
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	18	Total	O	0	0
			18	18		
4	B	30	Total	O	0	0
			30	30		

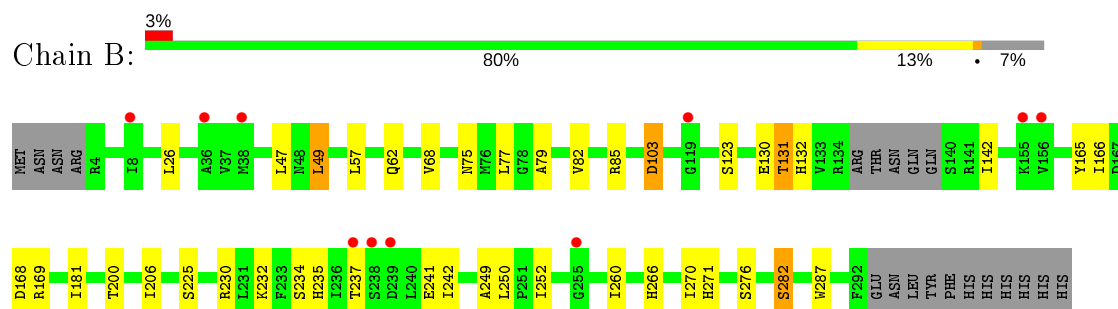
3 Residue-property plots [i](#)

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 ($\text{RSRZ} > 2$). 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: Probable inorganic polyphosphate/ATP-NAD kinase



- Molecule 1: Probable inorganic polyphosphate/ATP-NAD kinase



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	138.09 Å 65.16 Å 86.39 Å 90.00° 124.95° 90.00°	Depositor
Resolution (Å)	33.75 – 2.55 43.10 – 2.55	Depositor EDS
% Data completeness (in resolution range)	98.5 (33.75-2.55) 98.7 (43.10-2.55)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.06	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.58 (at 2.54 Å)	Xtriage
Refinement program	PHENIX (phenix.refine: dev_1032)	Depositor
R, R_{free}	0.185 , 0.241 0.186 , 0.240	Depositor DCC
R_{free} test set	1046 reflections (5.12%)	wwPDB-VP
Wilson B-factor (Å ²)	72.1	Xtriage
Anisotropy	0.315	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 50.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	4553	wwPDB-VP
Average B, all atoms (Å ²)	60.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.32% 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: ACY, SO4

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	0.39	0/2255	0.56	0/3063
1	B	0.38	0/2282	0.56	0/3100
All	All	0.39	0/4537	0.56	0/6163

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

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	2211	0	2213	20	0
1	B	2236	0	2244	22	0
2	A	16	0	12	2	0
2	B	32	0	24	2	0
3	A	5	0	0	0	0
3	B	5	0	0	0	0
4	A	18	0	0	0	0
4	B	30	0	0	2	0
All	All	4553	0	4493	43	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 5.

All (43) 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:B:131:THR:HG22	1:B:260:ILE:HG12	1.67	0.77
1:A:161:GLU:HG2	1:A:175:ARG:HG3	1.77	0.66
1:A:141:ARG:HH12	1:A:251:PRO:HD2	1.60	0.66
1:A:56:SER:HA	2:A:403:ACY:H3	1.81	0.63
1:A:206:ILE:HD12	1:A:225:SER:HA	1.82	0.61
1:B:242:ILE:HG12	1:B:252:ILE:HD11	1.82	0.61
1:B:234:SER:OG	1:B:235:HIS:N	2.32	0.61
1:B:123:SER:HB3	1:B:270:ILE:HG22	1.82	0.61
1:B:282:SER:HB2	1:B:287:TRP:HB2	1.83	0.60
1:B:103:ASP:OD2	1:B:271:HIS:ND1	2.31	0.59
1:A:165:TYR:HB2	1:A:230:ARG:HB2	1.84	0.58
1:A:241:GLU:HB3	1:A:249:ALA:HB1	1.84	0.58
1:B:168:ASP:OD1	1:B:230:ARG:NH2	2.37	0.57
1:A:155:LYS:HG2	1:A:158:HIS:HB2	1.86	0.57
1:B:232:LYS:NZ	4:B:529:HOH:O	2.39	0.55
1:B:26:LEU:HD21	1:B:68:VAL:HG11	1.88	0.55
1:B:206:ILE:HD12	1:B:225:SER:HA	1.90	0.53
1:A:242:ILE:HD13	1:A:252:ILE:HD11	1.90	0.53
1:A:42[A]:GLN:N	1:A:42[A]:GLN:OE1	2.37	0.53
1:A:57:LEU:HD21	1:A:79:ALA:HA	1.92	0.52
1:B:165:TYR:HB2	1:B:230:ARG:HB3	1.93	0.51
1:A:23:HIS:CD2	1:A:43:ILE:HD13	2.46	0.50
1:B:169:ARG:HA	2:B:409:ACY:H3	1.92	0.49
1:B:241:GLU:HB3	1:B:249:ALA:HB1	1.93	0.48
1:B:57:LEU:HD21	1:B:79:ALA:HA	1.95	0.48
1:A:145:ALA:HB2	1:A:244:CYS:HB3	1.97	0.47
1:A:103:ASP:OD2	1:A:271:HIS:ND1	2.47	0.47
1:A:151:LEU:HA	1:A:242:ILE:HD12	1.97	0.47
1:B:82:VAL:HA	1:B:85:ARG:NH1	2.30	0.46
1:B:181:ILE:HD13	1:B:260:ILE:HD12	1.98	0.44
1:B:131:THR:CG2	1:B:260:ILE:HG12	2.44	0.44
1:B:49:LEU:O	1:B:49:LEU:HD12	2.18	0.43
1:A:147:ASN:HB3	1:A:148:GLU:OE1	2.18	0.43
1:A:66:LEU:HD11	1:A:91:ILE:HG22	2.01	0.43
1:B:132:HIS:CE1	1:B:142:ILE:HG12	2.54	0.42
1:B:266:HIS:CD2	1:B:266:HIS:N	2.87	0.42
2:B:402:ACY:O	4:B:519:HOH:O	2.22	0.42
1:A:155:LYS:HE3	1:A:158:HIS:HB2	2.02	0.41
1:A:174:GLN:HE22	2:A:401[B]:ACY:H2	1.85	0.41
1:A:12:GLY:O	1:A:43:ILE:HD11	2.21	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:95:ARG:HB2	1:A:95:ARG:HE	1.54	0.40
1:B:77:LEU:HA	1:B:77:LEU:HD12	1.89	0.40
1:B:26:LEU:HD12	1:B:26:LEU:HA	1.84	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	279/304 (92%)	271 (97%)	8 (3%)	0	100	100
1	B	283/304 (93%)	273 (96%)	10 (4%)	0	100	100
All	All	562/608 (92%)	544 (97%)	18 (3%)	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	A	242/261 (93%)	233 (96%)	9 (4%)	34	45
1	B	244/261 (94%)	231 (95%)	13 (5%)	22	30
All	All	486/522 (93%)	464 (96%)	22 (4%)	27	37

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	13	HIS
1	A	103	ASP
1	A	123	SER
1	A	124	GLU
1	A	140	SER
1	A	228	THR
1	A	238	SER
1	A	261	ARG
1	A	292	PHE
1	B	47	LEU
1	B	49	LEU
1	B	62	GLN
1	B	75	ASN
1	B	103	ASP
1	B	130	GLU
1	B	131	THR
1	B	166	ILE
1	B	200	THR
1	B	237	THR
1	B	250	LEU
1	B	276	SER
1	B	282	SER

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](#)

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 [i](#)

14 ligands are 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$
3	SO4	A	404	-	4,4,4	0.11	0	6,6,6	0.22	0
2	ACY	B	409	-	1,3,3	2.21	1 (100%)	0,3,3	0.00	-
2	ACY	B	402	-	1,3,3	2.49	1 (100%)	0,3,3	0.00	-
2	ACY	A	403	-	1,3,3	1.92	0	0,3,3	0.00	-
2	ACY	B	403	-	1,3,3	1.47	0	0,3,3	0.00	-
2	ACY	B	407	-	1,3,3	1.65	0	0,3,3	0.00	-
2	ACY	A	401[A]	-	1,3,3	1.65	0	0,3,3	0.00	-
3	SO4	B	408	-	4,4,4	0.16	0	6,6,6	0.19	0
2	ACY	A	401[B]	-	1,3,3	1.59	0	0,3,3	0.00	-
2	ACY	A	402	-	1,3,3	1.58	0	0,3,3	0.00	-
2	ACY	B	404	-	1,3,3	1.87	0	0,3,3	0.00	-
2	ACY	B	406	-	1,3,3	1.60	0	0,3,3	0.00	-
2	ACY	B	401	-	1,3,3	1.91	0	0,3,3	0.00	-
2	ACY	B	405	-	1,3,3	2.32	1 (100%)	0,3,3	0.00	-

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	402	ACY	CH3-C	2.49	1.51	1.48
2	B	405	ACY	CH3-C	2.32	1.51	1.48
2	B	409	ACY	CH3-C	2.21	1.51	1.48

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

4 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	409	ACY	1	0
2	B	402	ACY	1	0
2	A	403	ACY	1	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	401[B]	ACY	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 ⓘ

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, 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	283/304 (93%)	0.46	16 (5%)	23 30	27, 56, 92, 128	1 (0%)
1	B	284/304 (93%)	0.39	10 (3%)	44 53	26, 59, 94, 114	3 (1%)
All	All	567/608 (93%)	0.43	26 (4%)	32 41	26, 58, 94, 128	4 (0%)

All (26) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	238	SER	6.0
1	B	238	SER	5.8
1	B	239	ASP	5.3
1	A	158	HIS	3.9
1	A	141	ARG	3.5
1	A	133	VAL	3.3
1	B	36	ALA	3.2
1	A	234	SER	3.1
1	A	239	ASP	3.0
1	A	13	HIS	3.0
1	A	237	THR	2.9
1	B	156	VAL	2.9
1	A	292	PHE	2.9
1	A	5	PHE	2.7
1	B	237	THR	2.6
1	A	235	HIS	2.6
1	B	255	GLY	2.5
1	B	155	LYS	2.4
1	A	156	VAL	2.4
1	B	8	ILE	2.4
1	A	104	LEU	2.2
1	A	98	LEU	2.1
1	A	16	HIS	2.1
1	B	119	GLY	2.1

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Mol	Chain	Res	Type	RSRZ
1	B	38	MET	2.0
1	A	31	LYS	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 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. 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
2	ACY	B	402	4/4	0.73	0.28	57,58,59,61	0
2	ACY	B	404	4/4	0.78	0.48	84,84,84,84	0
2	ACY	B	407	4/4	0.84	0.18	70,71,71,71	0
2	ACY	A	403	4/4	0.84	0.33	69,70,70,72	0
2	ACY	A	401[A]	4/4	0.86	0.29	60,60,60,60	4
2	ACY	A	401[B]	4/4	0.86	0.29	59,59,59,60	4
2	ACY	B	409	4/4	0.86	0.18	64,64,65,65	0
2	ACY	B	403	4/4	0.88	0.16	87,87,87,87	0
2	ACY	B	401	4/4	0.88	0.22	68,68,69,69	0
2	ACY	B	405	4/4	0.88	0.27	52,53,53,54	0
3	SO4	B	408	5/5	0.89	0.17	119,119,119,119	0
3	SO4	A	404	5/5	0.91	0.24	98,98,99,99	0
2	ACY	B	406	4/4	0.92	0.10	82,83,83,83	0
2	ACY	A	402	4/4	0.97	0.48	79,79,80,80	0

6.5 Other polymers [i](#)

There are no such residues in this entry.