



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 27, 2014 – 04:44 PM GMT

PDB ID : 2HIX  
Title : ATP dependent DNA ligase from *S. solfataricus* bound to ATP  
Authors : Pascal, J.M.; Ellenberger, T.  
Deposited on : 2006-06-29  
Resolution : 2.87 Å(reported)

This is a full wwPDB validation 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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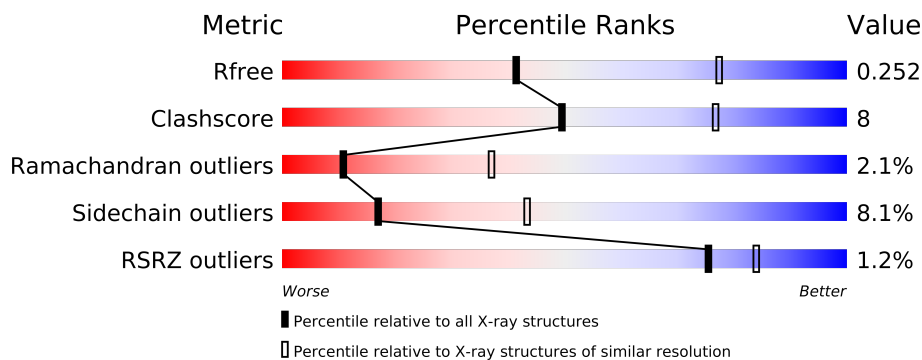
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : dev-1323  
EDS : stable22639  
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) : stable22683

# 1 Overall quality at a glance

The reported resolution of this entry is 2.87 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	1360 (2.90-2.86)
Clashscore	79885	1696 (2.90-2.86)
Ramachandran outliers	78287	1647 (2.90-2.86)
Sidechain outliers	78261	1650 (2.90-2.86)
RSRZ outliers	66119	1362 (2.90-2.86)

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	A	621	

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 4606 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.

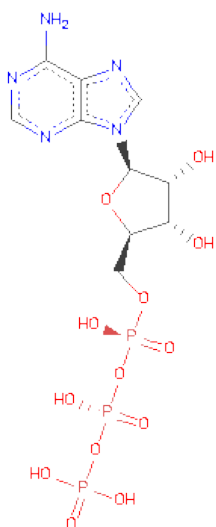
- Molecule 1 is a protein called Thermostable DNA ligase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	577	4571	2926	764	866	15	0	1	0

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-19	MET	-	CLONING ARTIFACT	UNP Q980T8
A	-18	GLY	-	CLONING ARTIFACT	UNP Q980T8
A	-17	SER	-	CLONING ARTIFACT	UNP Q980T8
A	-16	SER	-	CLONING ARTIFACT	UNP Q980T8
A	-15	HIS	-	EXPRESSION TAG	UNP Q980T8
A	-14	HIS	-	EXPRESSION TAG	UNP Q980T8
A	-13	HIS	-	EXPRESSION TAG	UNP Q980T8
A	-12	HIS	-	EXPRESSION TAG	UNP Q980T8
A	-11	HIS	-	EXPRESSION TAG	UNP Q980T8
A	-10	HIS	-	EXPRESSION TAG	UNP Q980T8
A	-9	SER	-	CLONING ARTIFACT	UNP Q980T8
A	-8	SER	-	CLONING ARTIFACT	UNP Q980T8
A	-7	GLY	-	CLONING ARTIFACT	UNP Q980T8
A	-6	LEU	-	CLONING ARTIFACT	UNP Q980T8
A	-5	VAL	-	CLONING ARTIFACT	UNP Q980T8
A	-4	PRO	-	CLONING ARTIFACT	UNP Q980T8
A	-3	ARG	-	CLONING ARTIFACT	UNP Q980T8
A	-2	GLY	-	CLONING ARTIFACT	UNP Q980T8
A	-1	SER	-	CLONING ARTIFACT	UNP Q980T8
A	0	HIS	-	CLONING ARTIFACT	UNP Q980T8

- Molecule 2 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		
2	A	1	31	10	5	13	3	0	0

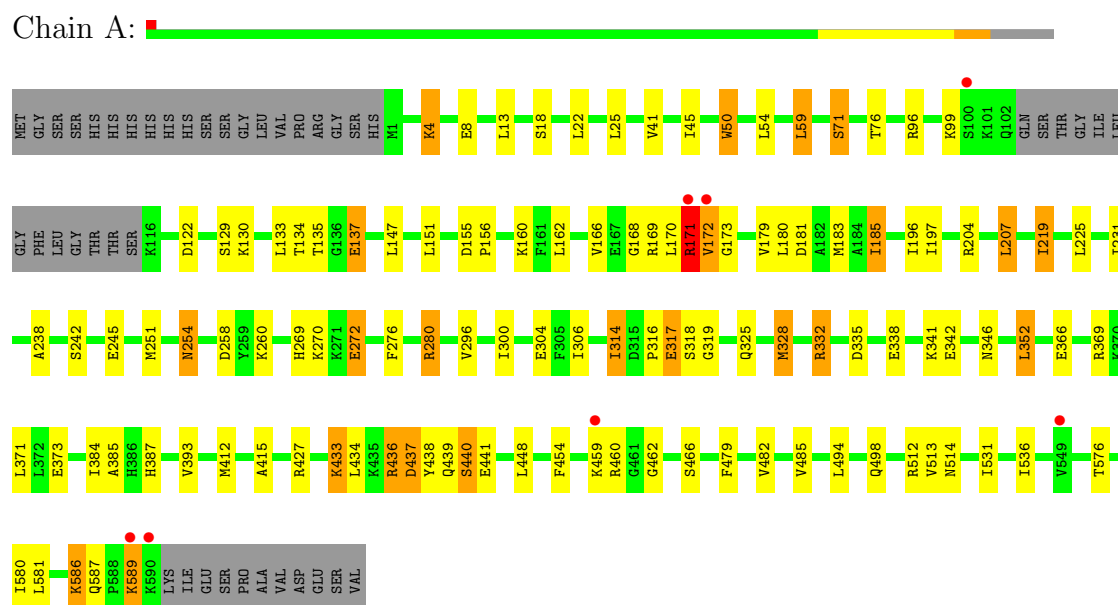
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	4	Total	O	0	0
			4	4		

### 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: Thermostable DNA ligase



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	119.32Å 171.65Å 78.69Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 2.87 47.54 – 2.86	Depositor EDS
% Data completeness (in resolution range)	95.0 (20.00-2.87) 94.6 (47.54-2.86)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.97 (at 2.86Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.217 , 0.279 0.205 , 0.252	Depositor DCC
$R_{free}$ test set	921 reflections (5.38%)	DCC
Wilson B-factor (Å <sup>2</sup> )	68.7	Xtriage
Anisotropy	0.389	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.30 , 50.0	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.51$ , $\langle L^2 \rangle = 0.34$	Xtriage
Outliers	0 of 18026 reflections	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	4606	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	49.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.63% 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: ATP

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	0.58	4/4653 (0.1%)	0.64	4/6271 (0.1%)

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	586	LYS	CD-CE	15.91	1.91	1.51
1	A	586	LYS	CE-NZ	7.41	1.67	1.49
1	A	589	LYS	CD-CE	7.35	1.69	1.51
1	A	462	GLY	C-O	6.82	1.34	1.23

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	586	LYS	CG-CD-CE	-6.45	92.56	111.90
1	A	352	LEU	CA-CB-CG	6.39	130.00	115.30
1	A	589	LYS	CD-CE-NZ	-5.42	99.23	111.70
1	A	586	LYS	CD-CE-NZ	-5.08	100.01	111.70

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	A	4571	0	4644	70	0
2	A	31	0	12	4	0
3	A	4	0	0	0	0
All	All	4606	0	4656	70	0

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 8.

All (70) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:586:LYS:NZ	1:A:586:LYS:CE	1.67	1.54
1:A:586:LYS:CE	1:A:586:LYS:CD	1.91	1.49
1:A:586:LYS:CG	1:A:586:LYS:CE	2.60	0.80
1:A:332:ARG:HG3	1:A:332:ARG:HH11	1.46	0.79
1:A:242:SER:HB3	1:A:437:ASP:OD2	1.83	0.79
1:A:171:ARG:HD2	1:A:171:ARG:H	1.50	0.74
1:A:96:ARG:HB2	1:A:160:LYS:HB2	1.70	0.74
1:A:436:ARG:O	1:A:439:GLN:HG2	1.88	0.74
1:A:196:ILE:HD12	1:A:219:ILE:HD12	1.73	0.70
1:A:183:MET:HE1	1:A:207:LEU:HD22	1.76	0.68
1:A:332:ARG:CG	1:A:332:ARG:HH11	2.07	0.66
1:A:454:PHE:HB2	1:A:466:SER:HB3	1.81	0.63
1:A:71:SER:HB2	1:A:76:THR:O	1.98	0.63
1:A:536:ILE:H	1:A:587:GLN:HE22	1.48	0.61
1:A:332:ARG:HG3	1:A:332:ARG:NH1	2.10	0.60
1:A:440:SER:O	1:A:441:GLU:HG2	2.01	0.60
1:A:204:ARG:HG2	1:A:231:ILE:HG21	1.84	0.60
1:A:433:LYS:NZ	2:A:602:ATP:O3A	2.35	0.59
1:A:317:GLU:O	1:A:319:GLY:N	2.37	0.57
1:A:335:ASP:HB3	1:A:338:GLU:HB2	1.87	0.56
1:A:260:LYS:HE2	2:A:602:ATP:H5'2	1.87	0.56
1:A:325:GLN:NE2	1:A:328:MET:SD	2.79	0.55
1:A:179:VAL:HB	1:A:207:LEU:HD11	1.87	0.55
1:A:269:HIS:HB2	1:A:276:PHE:HB2	1.89	0.55
1:A:448:LEU:HD12	1:A:531:ILE:HG13	1.89	0.55
1:A:183:MET:HE1	1:A:207:LEU:CD2	2.36	0.54
1:A:171:ARG:O	1:A:173:GLY:N	2.41	0.54
1:A:269:HIS:CD2	1:A:306:ILE:HG23	2.43	0.54
1:A:130:LYS:O	1:A:134:THR:HG22	2.08	0.53
1:A:341:LYS:HG3	1:A:342:GLU:N	2.22	0.53
1:A:296:VAL:HA	1:A:300:ILE:HD12	1.92	0.52
1:A:147:LEU:HD21	1:A:166:VAL:HG21	1.93	0.50
1:A:586:LYS:NZ	1:A:586:LYS:CD	2.74	0.50

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Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:A:280:ARG:NH1	2:A:602:ATP:O1G	2.40	0.49
1:A:181:ASP:O	1:A:185:ILE:HD13	2.12	0.49
1:A:180:LEU:HD22	1:A:197:ILE:HG22	1.94	0.48
1:A:314:ILE:HD13	1:A:346:ASN:HB2	1.95	0.48
1:A:180:LEU:HD23	1:A:207:LEU:HD21	1.95	0.48
1:A:180:LEU:HA	1:A:183:MET:HE2	1.96	0.48
1:A:238:ALA:CB	1:A:412:MET:HE1	2.43	0.48
1:A:41:VAL:O	1:A:45:ILE:HG12	2.14	0.47
1:A:162:LEU:O	1:A:166:VAL:HG23	2.14	0.47
1:A:4:LYS:O	1:A:8:GLU:HG2	2.15	0.46
1:A:270:LYS:O	1:A:304:GLU:HA	2.15	0.46
1:A:385:ALA:O	1:A:387:HIS:HD2	1.97	0.46
1:A:251:MET:CE	1:A:415:ALA:HB2	2.45	0.45
1:A:13:LEU:HD21	1:A:172:VAL:HG13	1.99	0.45
1:A:258:ASP:OD2	1:A:369:ARG:NH2	2.50	0.45
1:A:437:ASP:C	1:A:439:GLN:N	2.70	0.45
1:A:576:THR:O	1:A:580:ILE:HG12	2.17	0.45
1:A:99:LYS:NZ	1:A:151:LEU:O	2.45	0.44
1:A:269:HIS:NE2	1:A:306:ILE:HG23	2.32	0.44
1:A:180:LEU:HA	1:A:183:MET:CE	2.48	0.44
1:A:427:ARG:HH22	2:A:602:ATP:PG	2.41	0.44
1:A:207:LEU:HA	1:A:207:LEU:HD23	1.87	0.44
1:A:170:LEU:HA	1:A:170:LEU:HD23	1.74	0.43
1:A:133:LEU:HD23	1:A:133:LEU:HA	1.91	0.43
1:A:180:LEU:CD2	1:A:207:LEU:HD21	2.49	0.43
1:A:304:GLU:HG3	1:A:304:GLU:O	2.19	0.42
1:A:373:GLU:HG2	1:A:384:ILE:HG13	2.01	0.42
1:A:485:VAL:HG21	1:A:531:ILE:HD12	2.02	0.42
1:A:168:GLY:O	1:A:170:LEU:N	2.51	0.42
1:A:325:GLN:HE22	1:A:328:MET:CE	2.32	0.42
1:A:204:ARG:CG	1:A:231:ILE:HG21	2.49	0.42
1:A:251:MET:HE2	1:A:415:ALA:HB2	2.01	0.41
1:A:59:LEU:HD22	1:A:166:VAL:HG13	2.03	0.41
1:A:251:MET:HA	1:A:251:MET:HE2	2.02	0.41
1:A:254:ASN:HD22	1:A:254:ASN:HA	1.65	0.41
1:A:50:TRP:HB2	1:A:54:LEU:HD12	2.01	0.41
1:A:479:PHE:N	1:A:512:ARG:O	2.46	0.40

There are no symmetry-related clashes.

## 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	A	574/621 (92%)	535 (93%)	27 (5%)	12 (2%)	11 37

All (12) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	171	ARG
1	A	317	GLU
1	A	318	SER
1	A	437	ASP
1	A	172	VAL
1	A	438	TYR
1	A	137	GLU
1	A	169	ARG
1	A	436	ARG
1	A	272	GLU
1	A	316	PRO
1	A	156	PRO

### 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	A	492/536 (92%)	452 (92%)	40 (8%)	17 43

All (40) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	4	LYS
1	A	18	SER

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Mol	Chain	Res	Type
1	A	22	LEU
1	A	25	LEU
1	A	50	TRP
1	A	59	LEU
1	A	71	SER
1	A	122	ASP
1	A	129	SER
1	A	135	THR
1	A	137	GLU
1	A	155	ASP
1	A	171	ARG
1	A	185	ILE
1	A	207	LEU
1	A	219	ILE
1	A	225	LEU
1	A	245	GLU
1	A	254	ASN
1	A	272	GLU
1	A	280	ARG
1	A	314	ILE
1	A	328	MET
1	A	332	ARG
1	A	352	LEU
1	A	366	GLU
1	A	371	LEU
1	A	393	VAL
1	A	433	LYS
1	A	434	LEU
1	A	440	SER
1	A	459	LYS
1	A	460	ARG
1	A	482	VAL
1	A	494	LEU
1	A	498	GLN
1	A	513	VAL
1	A	514	ASN
1	A	581	LEU
1	A	589	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (6) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	46	GLN
1	A	254	ASN
1	A	387	HIS
1	A	391	ASN
1	A	542	HIS
1	A	587	GLN

### 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 ⓘ

1 ligand 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	ATP	A	602	-	33,33,33	1.08	2 (6%)	52,52,52	2.09	10 (19%)

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	ATP	A	602	-	-	0/22/38/38	0/1/3/3

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	602	ATP	C4-N9	-3.51	1.32	1.37
2	A	602	ATP	C5-C4	3.24	1.47	1.40

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	602	ATP	N3-C2-N1	-7.01	122.84	128.71
2	A	602	ATP	O4'-C1'-N9	7.01	114.96	108.44
2	A	602	ATP	PA-O3A-PB	-4.58	118.26	131.68
2	A	602	ATP	N3-C4-N9	4.01	132.66	125.43
2	A	602	ATP	C4-C5-N7	-3.96	106.13	109.52
2	A	602	ATP	PB-O3B-PG	-2.76	123.59	131.68
2	A	602	ATP	C5-C4-N3	-2.51	120.23	125.70
2	A	602	ATP	C2-N3-C4	2.40	120.84	114.01
2	A	602	ATP	C1'-N9-C4	-2.30	122.66	126.64
2	A	602	ATP	C2-N1-C6	2.25	122.83	118.77

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	A	577/621 (92%)	-0.21	7 (1%) 75 84	41, 49, 58, 68	1 (0%)

All (7) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	459	LYS	3.5
1	A	590	LYS	3.4
1	A	589	LYS	3.1
1	A	171	ARG	3.1
1	A	172	VAL	2.5
1	A	100	SER	2.1
1	A	549	VAL	2.0

### 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
2	ATP	A	602	31/31	0.17	-0.39	37,45,51,52	0

## 6.5 Other polymers ⓘ

There are no such residues in this entry.