



# Full wwPDB X-ray Structure Validation Report ⓘ

Jan 31, 2016 – 11:34 PM GMT

PDB ID : 1XSP  
Title : Crystal Structure of human DNA polymerase lambda in complex with nicked DNA and pyrophosphate  
Authors : Garcia-Diaz, M.; Bebenek, K.; Krahn, J.M.; Kunkel, T.A.; Pedersen, L.C.  
Deposited on : 2004-10-19  
Resolution : 2.20 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](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.

---

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

MolProbity : 4.02b-467  
Mogul : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
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) : trunk26865

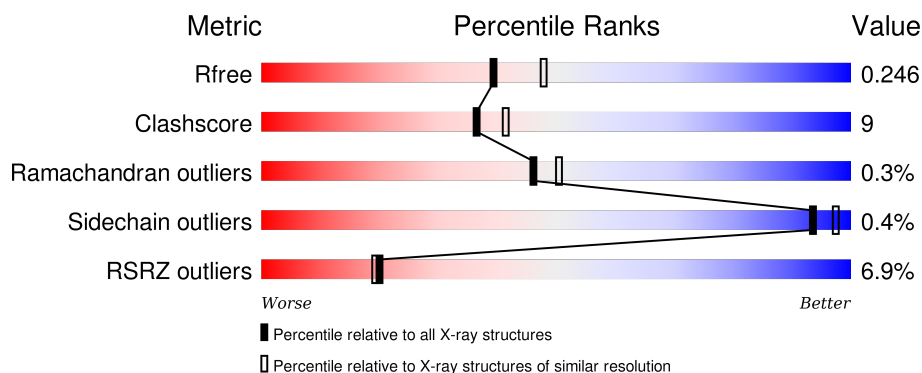
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.20 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))
$R_{free}$	91344	3774 (2.20-2.20)
Clashscore	102246	4477 (2.20-2.20)
Ramachandran outliers	100387	4404 (2.20-2.20)
Sidechain outliers	100360	4405 (2.20-2.20)
RSRZ outliers	91569	3781 (2.20-2.20)

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	T	11	 82% 18%
2	P	7	 71% 29%
3	D	4	 25% 75%
4	A	335	 7% 77% 20% •

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	NA	A	577	-	-	-	X

## 2 Entry composition

There are 7 unique types of molecules in this entry. The entry contains 3363 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 DNA chain called 5'-D(\*CP\*GP\*GP\*CP\*CP\*GP\*TP\*AP\*CP\*TP\*G)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	T	11	Total	C	N	O	P	0	0	0
			222	106	41	65	10			

- Molecule 2 is a DNA chain called 5'-D(\*CP\*AP\*GP\*TP\*AP\*CP\*G)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	P	7	Total	C	N	O	P	0	0	0
			141	68	28	39	6			

- Molecule 3 is a DNA chain called 5'-D(P\*GP\*CP\*CP\*G)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	4	Total	C	N	O	P	0	0	0
			83	38	16	25	4			

- Molecule 4 is a protein called DNA polymerase lambda.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	A	327	Total	C	N	O	S	0	5	0
			2570	1610	470	479	11			

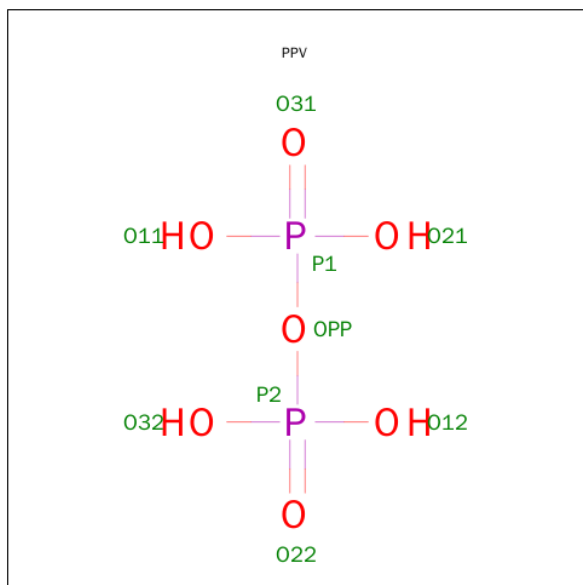
There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	241	MET	-	INITIATING METHIONINE	UNP Q9UGP5
A	543	ALA	CYS	ENGINEERED	UNP Q9UGP5

- Molecule 5 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	3	Total Na 3 3	0	0
5	D	1	Total Na 1 1	0	0

- Molecule 6 is PYROPHOSPHATE (three-letter code: PPV) (formula:  $\text{H}_4\text{O}_7\text{P}_2$ ).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	1	Total O P 9 7 2	0	0


- Molecule 7 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	229	Total O 229 229	0	0
7	D	11	Total O 11 11	0	0
7	P	28	Total O 28 28	0	0
7	T	66	Total O 66 66	0	0

### 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: 5'-D(\*CP\*GP\*GP\*CP\*CP\*GP\*TP\*AP\*CP\*TP\*G)-3'

Chain T: 



- Molecule 2: 5'-D(\*CP\*AP\*GP\*TP\*AP\*CP\*G)-3'

Chain P: 




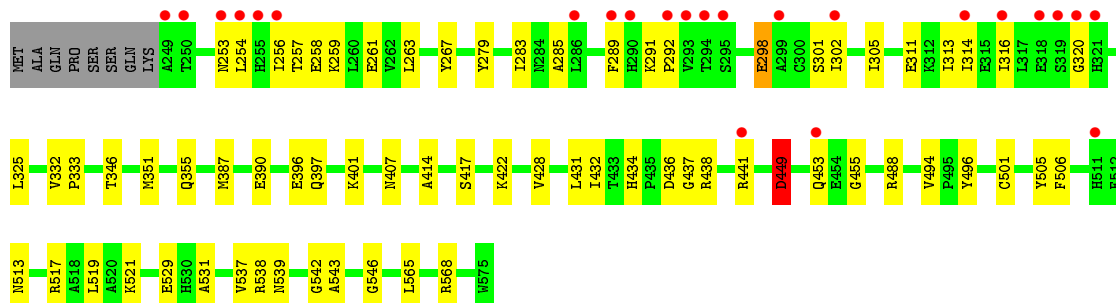
- Molecule 3: 5'-D(P\*GP\*CP\*CP\*G)-3'

Chain D: 



- Molecule 4: DNA polymerase lambda

Chain A: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	55.84Å 62.76Å 140.72Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	41.72 – 2.20 41.72 – 2.19	Depositor EDS
% Data completeness (in resolution range)	94.0 (41.72-2.20) 93.6 (41.72-2.19)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.11	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.55 (at 2.20Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, $R_{free}$	0.206 , 0.242 0.213 , 0.246	Depositor DCC
$R_{free}$ test set	1165 reflections (4.79%)	DCC
Wilson B-factor (Å <sup>2</sup> )	35.1	Xtriage
Anisotropy	0.403	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.29 , 48.0	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.31$	Xtriage
Outliers	0 of 25649 reflections	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	3363	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	41.0	wwPDB-VP

Xtriage'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, 0.375 respectively for untwinned datasets, and 0.333, 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: NA, PPV

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	T	0.37	0/248	0.79	0/381
2	P	0.43	0/158	0.67	0/242
3	D	0.96	1/92 (1.1%)	0.73	0/138
4	A	0.39	0/2621	0.63	3/3540 (0.1%)
All	All	0.42	1/3119 (0.0%)	0.65	3/4301 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
4	A	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	D	1	DG	OP3-P	-6.76	1.53	1.61

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	449	ASP	O-C-N	-8.32	109.38	122.70
4	A	298	GLU	C-N-CA	5.52	135.50	121.70
4	A	298	GLU	CA-C-N	-5.23	105.70	117.20

There are no chirality outliers.

All (1) planarity outliers are listed below:



Mol	Chain	Res	Type	Group
4	A	449	ASP	Mainchain

## 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	T	222	0	125	1	0
2	P	141	0	80	1	0
3	D	83	0	45	1	0
4	A	2570	0	2524	52	0
5	A	3	0	0	0	0
5	D	1	0	0	0	0
6	A	9	0	0	0	0
7	A	229	0	0	7	0
7	D	11	0	0	0	0
7	P	28	0	0	0	0
7	T	66	0	0	0	0
All	All	3363	0	2774	55	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 9.

All (55) 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)
4:A:256:ILE:HD13	4:A:313:ILE:HG23	1.59	0.84
4:A:417:SER:HB2	4:A:422[B]:LYS:HD3	1.60	0.84
4:A:291:LYS:HE3	4:A:298:GLU:OE2	1.88	0.74
4:A:488:ARG:HD2	7:A:731:HOH:O	1.91	0.70
4:A:396:GLU:HG3	4:A:414:ALA:HB2	1.72	0.70
4:A:256:ILE:HG12	4:A:316:ILE:HG21	1.75	0.69
4:A:438:ARG:O	4:A:441:ARG:HG3	1.96	0.65
4:A:320:GLY:HA2	7:A:692:HOH:O	1.98	0.63
4:A:302:ILE:HB	4:A:305:ILE:HD12	1.80	0.63
4:A:537:VAL:HB	4:A:546:GLY:HA3	1.82	0.60
4:A:519:LEU:HD23	4:A:565:LEU:HD11	1.83	0.60
4:A:289:PHE:CE2	4:A:291:LYS:O	2.56	0.58

*Continued on next page...*

*Continued from previous page...*

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:A:289:PHE:HE2	4:A:291:LYS:O	1.86	0.58
4:A:259:LYS:NZ	7:A:778:HOH:O	2.37	0.57
4:A:351:MET:O	4:A:355:GLN:HG3	2.05	0.56
4:A:256:ILE:HG12	4:A:316:ILE:CG2	2.35	0.56
4:A:397:GLN:O	4:A:401:LYS:HG3	2.05	0.56
4:A:539:ASN:HD21	4:A:543:ALA:HB3	1.70	0.55
4:A:449:ASP:O	4:A:453:GLN:HG3	2.07	0.54
4:A:417:SER:CB	4:A:422[B]:LYS:HD3	2.37	0.53
4:A:521:LYS:HE2	4:A:538:ARG:NE	2.25	0.52
4:A:298:GLU:O	4:A:301:SER:HB2	2.10	0.51
4:A:346[B]:THR:HG23	7:A:604:HOH:O	2.10	0.50
4:A:261:GLU:HG2	4:A:283:ILE:HD13	1.93	0.49
4:A:302:ILE:HD12	4:A:305:ILE:HD12	1.94	0.49
2:P:6:DC:H2'	2:P:7:DG:C8	2.48	0.49
4:A:253:ASN:OD1	4:A:292:PRO:HA	2.13	0.49
4:A:431:LEU:HD12	4:A:432:ILE:N	2.29	0.48
4:A:256:ILE:HG23	4:A:316:ILE:HD12	1.96	0.48
4:A:434:HIS:O	4:A:496:TYR:HB2	2.14	0.48
4:A:521:LYS:HE2	4:A:538:ARG:HE	1.78	0.47
4:A:390:GLU:HB3	7:A:681:HOH:O	2.14	0.47
4:A:539:ASN:ND2	4:A:543:ALA:HB3	2.30	0.47
4:A:285:ALA:O	4:A:289:PHE:HB2	2.15	0.47
4:A:519:LEU:CD2	4:A:565:LEU:HD21	2.46	0.46
4:A:513:ASN:O	4:A:517:ARG:HG3	2.15	0.46
3:D:3:DC:H2''	3:D:4:DG:C8	2.50	0.46
4:A:332:VAL:HB	4:A:333:PRO:HD3	1.98	0.45
4:A:436:ASP:OD1	4:A:437:GLY:N	2.49	0.45
4:A:538:ARG:HD3	4:A:542:GLY:O	2.16	0.45
4:A:261:GLU:CG	4:A:283:ILE:HD13	2.47	0.44
4:A:279:TYR:O	4:A:283:ILE:HG13	2.17	0.43
4:A:565:LEU:O	7:A:766:HOH:O	2.22	0.43
4:A:387:MET:CE	4:A:428:VAL:HG23	2.48	0.43
4:A:311:GLU:O	4:A:314:ILE:HB	2.19	0.42
4:A:501:CYS:SG	4:A:531:ALA:HA	2.60	0.42
4:A:505:TYR:CG	4:A:529:GLU:HB3	2.55	0.42
4:A:263:LEU:HG	4:A:267:TYR:CE2	2.54	0.42
4:A:453:GLN:C	4:A:455:GLY:H	2.23	0.42
4:A:431:LEU:HD11	4:A:494:VAL:HG22	2.02	0.41
4:A:568:ARG:HD2	7:A:769:HOH:O	2.19	0.41
4:A:254:LEU:O	4:A:258:GLU:HB2	2.21	0.41
4:A:257:THR:O	4:A:261:GLU:HG3	2.21	0.41

*Continued on next page...*

*Continued from previous page...*

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
4:A:259:LYS:HB3	4:A:325:LEU:HD11	2.04	0.40
1:T:8:DA:H2''	1:T:9:DC:O5'	2.21	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
4	A	330/335 (98%)	315 (96%)	14 (4%)	1 (0%)	46 50

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
4	A	407	ASN

### 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
4	A	267/280 (95%)	266 (100%)	1 (0%)	93 97

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

Mol	Chain	Res	Type
4	A	506	PHE

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](#)

Of 5 ligands modelled in this entry, 4 are monoatomic - leaving 1 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	PPV	A	579	5	6,8,8	1.06	1 (16%)	11,13,13	1.31	1 (9%)

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	PPV	A	579	5	-	0/6/6/6	0/0/0/0

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	579	PPV	P2-O12	-2.22	1.46	1.54

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed( $^{\circ}$ )	Ideal( $^{\circ}$ )
6	A	579	PPV	O32-P2-OPP	-2.26	94.86	105.09

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 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, 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	T	11/11 (100%)	-0.73	0 100 100	25, 27, 33, 40	0
2	P	7/7 (100%)	-0.23	0 100 100	22, 22, 25, 27	0
3	D	4/4 (100%)	-0.57	0 100 100	35, 40, 40, 43	0
4	A	327/335 (97%)	0.15	24 (7%) 18 17	19, 39, 88, 98	0
All	All	349/357 (97%)	0.10	24 (6%) 20 19	19, 38, 87, 98	0

All (24) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	A	319	SER	6.8
4	A	256	ILE	4.6
4	A	254	LEU	4.4
4	A	292	PRO	4.2
4	A	293	VAL	4.2
4	A	314	ILE	4.2
4	A	249	ALA	4.1
4	A	289	PHE	3.9
4	A	255	HIS	3.9
4	A	290	HIS	3.8
4	A	320	GLY	3.2
4	A	316	ILE	2.8
4	A	321	HIS	2.7
4	A	295	SER	2.6
4	A	250	THR	2.6
4	A	453	GLN	2.6
4	A	294	THR	2.4
4	A	302	ILE	2.3
4	A	299	ALA	2.3
4	A	286	LEU	2.3
4	A	253	ASN	2.3

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
4	A	441	ARG	2.3
4	A	511[A]	HIS	2.2
4	A	318	GLU	2.1

## 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(Å <sup>2</sup> )	Q<0.9
5	NA	A	577	1/1	0.97	0.22	3.85	29,29,29,29	0
6	PPV	A	579	9/9	0.94	0.16	0.96	32,40,49,49	0
5	NA	D	503	1/1	0.51	0.41	-	79,79,79,79	0
5	NA	A	578	1/1	0.77	0.10	-	43,43,43,43	0
5	NA	A	576	1/1	0.92	0.11	-	28,28,28,28	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.