



wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 02:45 AM GMT

PDB ID : 2IHM
Title : Polymerase mu in ternary complex with gapped 11mer DNA duplex and bound incoming nucleotide
Authors : Moon, A.F.; Pedersen, L.C; Kunkel, T.A.
Deposited on : 2006-09-26
Resolution : 2.40 Å(reported)

This is a wwPDB X-ray Structure Validation Summary Report for a publicly released PDB entry.
We welcome your comments at 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

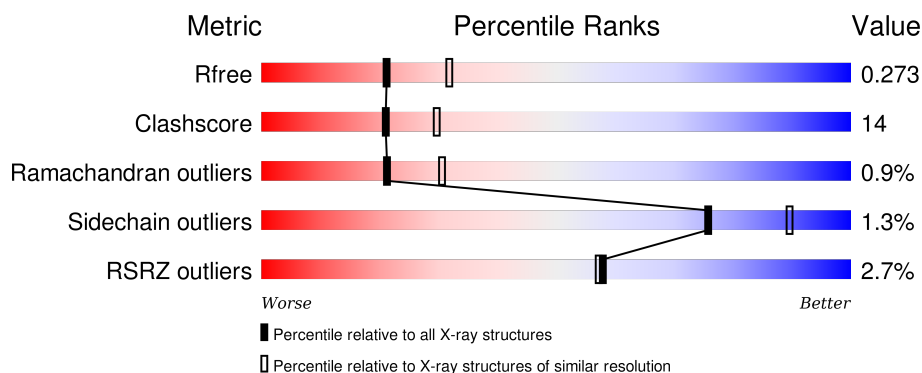
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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	2919 (2.40-2.40)
Clashscore	102246	3407 (2.40-2.40)
Ramachandran outliers	100387	3351 (2.40-2.40)
Sidechain outliers	100360	3352 (2.40-2.40)
RSRZ outliers	91569	2928 (2.40-2.40)

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. 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	<div> <div>36%</div> <div>64%</div> </div>
1	U	11	<div> <div>55%</div> <div>45%</div> </div>
2	P	6	<div> <div>33%</div> <div>33%</div> <div>33%</div> </div>
2	Q	6	<div> <div>50%</div> <div>17%</div> <div>33%</div> </div>
3	D	4	<div> <div>50%</div> <div>50%</div> </div>

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Mol	Chain	Length	Quality of chain
3	E	4	
4	A	360	
4	B	360	

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
6	NA	A	902	-	-	-	X

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 6340 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*AP*AP*TP*AP*CP*TP*G)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	T	11	Total	C	N	O	P	0	0	0
			223	107	43	63	10			
1	U	11	Total	C	N	O	P	0	0	0
			223	107	43	63	10			

- Molecule 2 is a DNA chain called 5'-D(*CP*AP*GP*TP*AP*T)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	P	6	Total	C	N	O	P	0	0	0
			119	59	22	33	5			
2	Q	6	Total	C	N	O	P	0	0	0
			119	59	22	33	5			

- 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			
3	E	4	Total	C	N	O	P	0	0	0
			83	38	16	25	4			

- Molecule 4 is a protein called DNA polymerase mu.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	A	332	Total	C	N	O	S	0	1	0
			2632	1666	472	485	9			
4	B	336	Total	C	N	O	S	0	1	0
			2614	1658	466	480	10			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	386	VAL	ALA	VARIATION	UNP Q9JIW4
B	386	VAL	ALA	VARIATION	UNP Q9JIW4

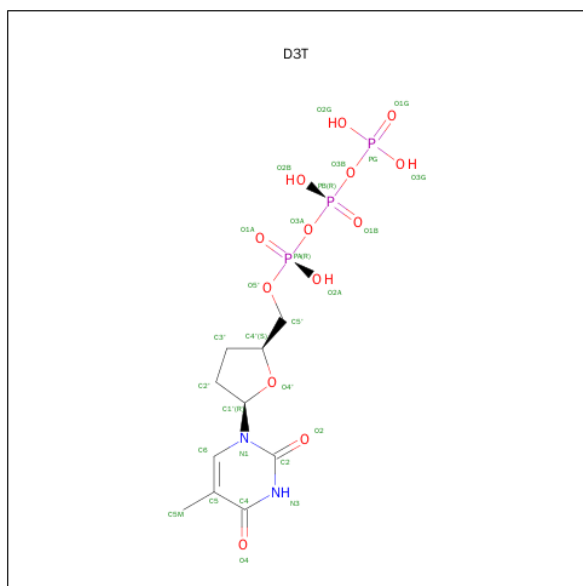
- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

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

- Molecule 6 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	B	1	Total Na 1 1	0	0
6	A	2	Total Na 2 2	0	0

- Molecule 7 is 2',3'-DIDEOXY-THYMIDINE-5'-TRIPHOSPHATE (three-letter code: D3T) (formula: $\text{C}_{10}\text{H}_{17}\text{N}_2\text{O}_{13}\text{P}_3$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
7	A	2	Total	C	N	O	P	0	0
			56	20	4	26	6		

- Molecule 8 is water.

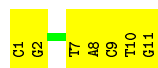
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	83	Total 83	O 83	0	0
8	B	80	Total 80	O 80	0	0
8	D	2	Total 2	O 2	0	0
8	E	2	Total 2	O 2	0	0
8	P	5	Total 5	O 5	0	0
8	Q	6	Total 6	O 6	0	0
8	T	2	Total 2	O 2	0	0
8	U	3	Total 3	O 3	0	0

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*AP*AP*TP*AP*CP*TP*G)-3'

Chain T: 



- Molecule 1: 5'-D(*CP*GP*GP*CP*AP*AP*TP*AP*CP*TP*G)-3'

Chain U: 



- Molecule 2: 5'-D(*CP*AP*GP*TP*AP*T)-3'

Chain P: 



- Molecule 2: 5'-D(*CP*AP*GP*TP*AP*T)-3'

Chain Q: 



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

Chain D: 



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

Chain E: 



Chain A:

Chain B:

4% 66% 26% 7%

S137 M138 P139 A140 Y141 R145 T154 S157 E158 E161 G168 N172 R175 L176 R181 P203 Y204 Z205 G206 V212 C222 E223 Q227 E232 R253 W254 Y255 Q256 L259 R260 T261 L262 D263 E264 L265 R266 E267 Q268 P269 Q270 R271 L272 T273 Q274 Q275

Q276 Y282 V290 L298 Q299 I302 E303 A304 A305 V306 R307 V315 T318 G319 Q327 E339 E340 G341 Q342 E343 L346 L347 P348 P349 V350 K351 S352 Q355 L361 Y362 H363 Q364 Y365 HIS ARG SER HIS LEU ALA ASP SER ALA HIS ASN LEU ARG GLN ARG SER

SER THR MET ASP VAL F387 E388 F391 G395 L396 P397 Q398 Q401 A402 ALA LEU ALA A406 G407 W414 R418 V419 D420 S426 F429 P430 F431 L434 F441 F442 L446 R447 R448 F449 R450 S451 Q452 Q453 R454 G455 L456 W457 L458 M459 G462 L463 F464 F472

4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	71.03 Å 96.08 Å 73.09 Å 90.00° 106.55° 90.00°	Depositor
Resolution (Å)	50.00 – 2.40 32.91 – 2.40	Depositor EDS
% Data completeness (in resolution range)	99.7 (50.00-2.40) 95.7 (32.91-2.40)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	0.11	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.48 (at 2.39 Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.230 , 0.277 0.229 , 0.273	Depositor DCC
R_{free} test set	1725 reflections (5.13%)	DCC
Wilson B-factor (Å ²)	53.3	Xtriage
Anisotropy	0.227	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.30 , 40.1	EDS
Estimated twinning fraction	0.024 for l,-k,h	Xtriage
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Outliers	0 of 36783 reflections	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	6340	wwPDB-VP
Average B, all atoms (Å ²)	57.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.94% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: NA, D3T, MG

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	0/250	0.63	0/384
1	U	0.37	0/250	0.65	0/384
2	P	2.20	2/133 (1.5%)	2.17	5/203 (2.5%)
2	Q	2.21	2/133 (1.5%)	2.71	6/203 (3.0%)
3	D	0.94	1/92 (1.1%)	0.84	0/138
3	E	0.99	1/92 (1.1%)	0.83	0/138
4	A	0.38	0/2692	0.59	1/3646 (0.0%)
4	B	0.37	0/2676	0.56	0/3634
All	All	0.60	6/6318 (0.1%)	0.78	12/8730 (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
1	U	0	1
2	P	0	1
2	Q	0	3
3	E	0	1
All	All	0	6

The worst 5 of 6 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	Q	4	DT	C4'-O4'	23.62	1.68	1.45
2	P	4	DT	C4'-O4'	20.35	1.65	1.45
2	P	4	DT	O4'-C1'	14.24	1.59	1.42
2	Q	4	DT	O4'-C1'	7.74	1.51	1.42
3	D	1	DG	OP3-P	-7.25	1.52	1.61

The worst 5 of 12 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
2	Q	4	DT	O4'-C1'-N1	26.85	126.79	108.00
2	P	4	DT	C1'-O4'-C4'	-17.55	92.55	110.10
2	Q	4	DT	C1'-O4'-C4'	-15.16	94.94	110.10
2	P	4	DT	O4'-C1'-C2'	15.05	117.94	105.90
2	Q	4	DT	O4'-C1'-C2'	13.47	116.67	105.90

There are no chirality outliers.

5 of 6 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	P	5	DA	Sidechain
2	Q	3	DG	Sidechain
2	Q	4	DT	Sidechain
2	Q	5	DA	Sidechain
1	U	7	DT	Sidechain

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	223	0	125	6	0
1	U	223	0	125	4	0
2	P	119	0	68	6	0
2	Q	119	0	68	8	0
3	D	83	0	45	1	0
3	E	83	0	45	2	0
4	A	2632	0	2557	75	0
4	B	2614	0	2523	77	0
5	A	1	0	0	0	0
5	B	1	0	0	0	0
6	A	2	0	0	0	0
6	B	1	0	0	0	0
7	A	56	0	26	0	0
8	A	83	0	0	2	0
8	B	80	0	0	3	0
8	D	2	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
8	E	2	0	0	0	0
8	P	5	0	0	0	0
8	Q	6	0	0	1	0
8	T	2	0	0	0	0
8	U	3	0	0	0	0
All	All	6340	0	5582	168	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 14.

The worst 5 of 168 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)
2:Q:4:DT:C4'	2:Q:4:DT:O4'	1.68	1.40
2:P:4:DT:O4'	2:P:4:DT:C4'	1.65	1.40
4:B:172[B]:ASN:ND2	4:B:175:ARG:NH1	2.20	0.90
4:A:172[B]:ASN:HD21	4:A:175:ARG:NH1	1.71	0.88
4:B:172[B]:ASN:ND2	4:B:175:ARG:HH11	1.73	0.87

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	327/360 (91%)	313 (96%)	12 (4%)	2 (1%)	30	43
4	B	331/360 (92%)	310 (94%)	17 (5%)	4 (1%)	16	23
All	All	658/720 (91%)	623 (95%)	29 (4%)	6 (1%)	21	30

5 of 6 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
4	B	340	GLU
4	A	386	VAL
4	A	468	GLN
4	B	426	SER
4	B	455	GLY

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	
4	A	277/308 (90%)	275 (99%)	2 (1%)	88	95
4	B	271/308 (88%)	266 (98%)	5 (2%)	66	84
All	All	548/616 (89%)	541 (99%)	7 (1%)	76	89

5 of 7 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	B	343	GLU
4	B	418	ARG
4	B	363	HIS
4	A	388	GLU
4	B	414	TRP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 9 such sidechains are listed below:

Mol	Chain	Res	Type
4	B	227	GLN
4	B	440	GLN
4	B	357	GLN
4	A	363	HIS
4	B	300	GLN

5.3.3 RNA ⓘ

There are no RNA molecules 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 7 ligands modelled in this entry, 5 are monoatomic - leaving 2 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	$\# Z > 2$
7	D3T	A	538	5	20,29,29	1.63	2 (10%)	27,45,45	3.23	3 (11%)
7	D3T	A	638	5	20,29,29	1.49	2 (10%)	27,45,45	3.21	3 (11%)

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
7	D3T	A	538	5	-	0/18/31/31	0/2/2/2
7	D3T	A	638	5	-	0/18/31/31	0/2/2/2

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
7	A	638	D3T	C6-N1	3.63	1.40	1.35
7	A	538	D3T	C4-N3	3.92	1.40	1.33
7	A	638	D3T	C4-N3	4.02	1.40	1.33
7	A	538	D3T	C6-N1	4.34	1.41	1.35

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
7	A	638	D3T	C5-C4-N3	-8.35	115.84	125.14
7	A	538	D3T	C5-C4-N3	-8.12	116.10	125.14
7	A	538	D3T	C5M-C5-C6	2.16	122.96	118.62
7	A	638	D3T	O4'-C1'-N1	2.59	112.20	107.72
7	A	638	D3T	C4-N3-C2	13.58	126.99	115.25

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, 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	T	11/11 (100%)	-0.25	0 100 100	44, 57, 77, 85	0
1	U	11/11 (100%)	-0.19	0 100 100	41, 56, 80, 85	0
2	P	6/6 (100%)	-0.04	0 100 100	34, 37, 56, 61	0
2	Q	6/6 (100%)	0.01	0 100 100	41, 44, 60, 68	0
3	D	4/4 (100%)	-0.24	0 100 100	60, 62, 64, 65	0
3	E	4/4 (100%)	-0.32	0 100 100	42, 43, 52, 60	0
4	A	332/360 (92%)	0.06	6 (1%) 71 71	28, 52, 76, 95	0
4	B	336/360 (93%)	0.18	13 (3%) 43 44	29, 61, 92, 112	0
All	All	710/762 (93%)	0.10	19 (2%) 58 57	28, 56, 89, 112	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	B	402	ALA	7.2
4	B	407	ALA	4.1
4	A	369	HIS	3.8
4	B	388	GLU	3.7
4	B	472	PHE	3.5

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, 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	LLDF	B-factors(Å ²)	Q<0.9
6	NA	A	902	1/1	0.92	0.30	11.19	40,40,40,40	1
6	NA	B	901	1/1	0.83	0.24	1.96	47,47,47,47	0
5	MG	B	800	1/1	0.85	0.21	1.91	57,57,57,57	0
7	D3T	A	538	28/28	0.98	0.22	1.20	28,34,38,44	0
7	D3T	A	638	28/28	0.98	0.18	0.59	35,41,46,50	0
6	NA	A	900	1/1	0.91	0.15	-0.08	42,42,42,42	0
5	MG	A	700	1/1	0.97	0.20	-	34,34,34,34	0

6.5 Other polymers

There are no such residues in this entry.