



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 13, 2018 – 11:19 pm GMT

PDB ID : 1X9M  
Title : T7 DNA polymerase in complex with an N-2-acetylaminofluorene-adducted DNA  
Authors : Dutta, S.; Li, Y.; Johnson, D.; Dzantiev, L.; Richardson, C.C.; Romano, L.J.; Ellenberger, T.  
Deposited on : 2004-08-23  
Resolution : 2.10 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](mailto: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.

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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
Xtriage (Phenix)	:	1.13
EDS	:	trunk31020
Percentile statistics	:	20171227.v01 (using entries in the PDB archive December 27th 2017)
Refmac	:	5.8.0158
CCP4	:	7.0 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk31020

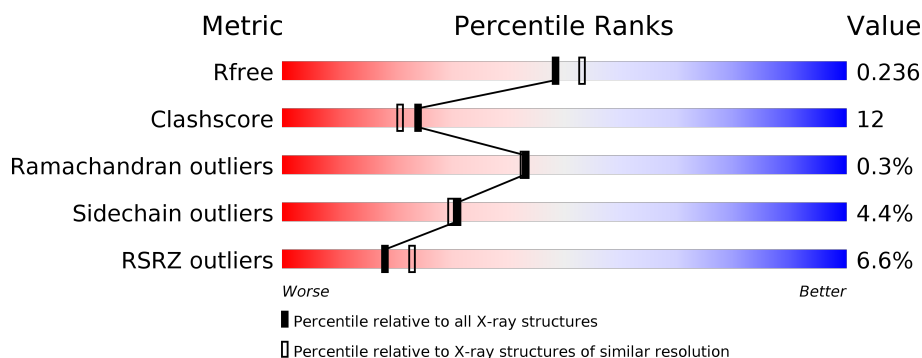
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.10 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))
$R_{free}$	111664	4608 (2.10-2.10)
Clashscore	122126	5109 (2.10-2.10)
Ramachandran outliers	120053	5059 (2.10-2.10)
Sidechain outliers	120020	5060 (2.10-2.10)
RSRZ outliers	108989	4497 (2.10-2.10)

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	C	22	<div> <div>5%</div> <div>14% 18% 14% 55%</div> </div>
2	D	26	<div> <div>4%</div> <div>27% 8% 12% 54%</div> </div>
3	A	698	<div> <div>6%</div> <div>74% 21% ..</div> </div>
4	B	108	<div> <div>10%</div> <div>69% 26% ..</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 crite-

ria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
1	2DT	C	22	-	-	X	-

## 2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 6824 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(\*GP\*GP\*AP\*GP\*AP\*GP\*TP\*GP\*AP\*TP\*TP\*GP\*GP\*TP\*AP\*GP\*TP\*GP\*TP\*GP\*AP\*(2DT))-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	C	10	Total	C	N	O	P	0	0	0
			209	100	38	61	10			

- Molecule 2 is a DNA chain called 5'-D(\*CP\*CP\*CP\*(8FG)P\*AP\*TP\*CP\*AP\*CP\*AP\*CP\*TP\*AP\*CP\*CP\*AP\*AP\*TP\*CP\*AP\*CP\*TP\*CP\*TP\*CP\*C)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	D	12	Total	C	N	O	P	0	0	0
			258	130	45	71	12			

- Molecule 3 is a protein called DNA polymerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	A	675	Total	C	N	O	S	0	0	0
			5251	3355	917	955	24			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	?	-	LYS	DELETION	UNP P00581
A	?	-	ARG	DELETION	UNP P00581
A	?	-	PHE	DELETION	UNP P00581
A	?	-	GLY	DELETION	UNP P00581
A	?	-	SER	DELETION	UNP P00581
A	?	-	HIS	DELETION	UNP P00581

- Molecule 4 is a protein called Thioredoxin 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	B	105	Total	C	N	O	S	0	0	0
			790	514	129	144	3			

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

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

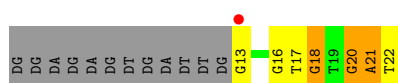
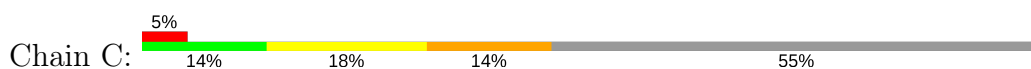
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	C	11	Total 11	O 11	0	0
6	D	23	Total 23	O 23	0	0
6	A	266	Total 266	O 266	0	0
6	B	15	Total 15	O 15	0	0

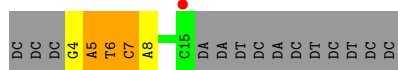
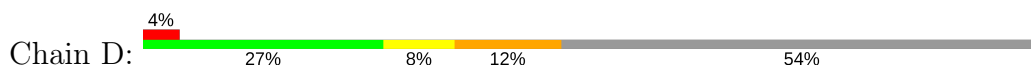
### 3 Residue-property plots [i](#)

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 ( $RSRZ > 2$ ). 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.

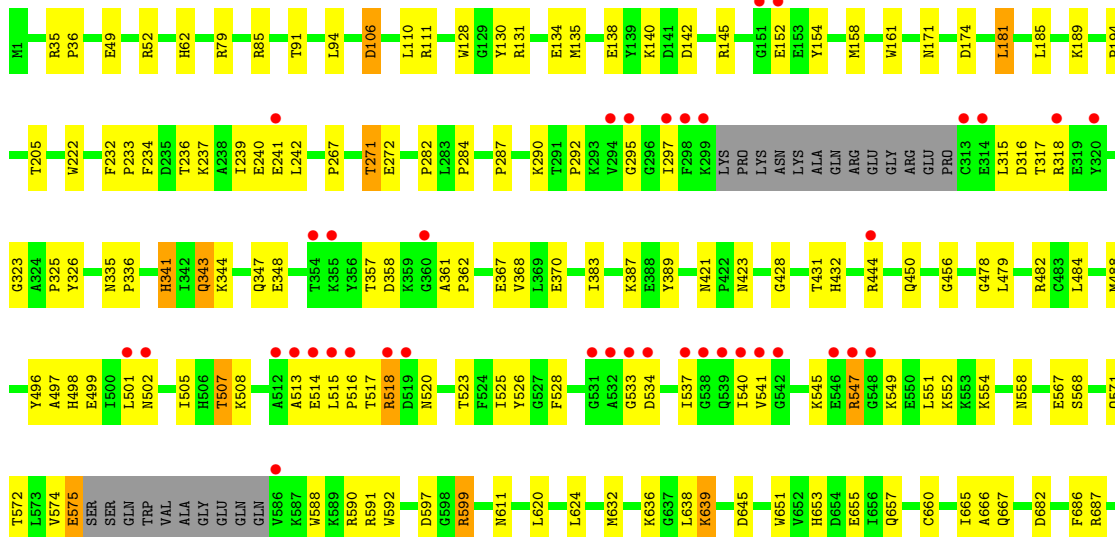
- Molecule 1: 5'-D(\*GP\*GP\*AP\*GP\*AP\*GP\*TP\*GP\*AP\*TP\*TP\*GP\*GP\*TP\*AP\*GP\*TP\*GP\*TP\*GP\*AP\*(2DT))-3'



- Molecule 2: 5'-D(\*CP\*CP\*CP\*(8FG)P\*AP\*TP\*CP\*AP\*CP\*AP\*CP\*TP\*AP\*CP\*CP\*AP\*A P\*TP\*CP\*AP\*CP\*TP\*CP\*TP\*CP\*C)-3'

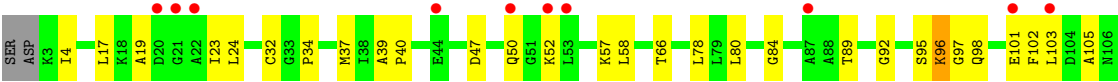


- Molecule 3: DNA polymerase





● Molecule 4: Thioredoxin 1



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	105.11Å 212.31Å 52.07Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.38 – 2.10 47.38 – 2.10	Depositor EDS
% Data completeness (in resolution range)	94.3 (47.38-2.10) 94.4 (47.38-2.10)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.61 (at 2.10Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, $R_{free}$	0.213 , 0.236 0.212 , 0.236	Depositor DCC
$R_{free}$ test set	3239 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	27.1	Xtriage
Anisotropy	0.299	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 48.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.47$ , $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	6824	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	34.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.95% 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, 0.333 respectively for untwinned datasets, and 0.375, 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: 2DT, MG, 8FG

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	C	0.52	0/213	0.87	0/328
2	D	0.53	0/244	0.99	0/372
3	A	0.39	0/5380	0.60	0/7299
4	B	0.33	0/805	0.59	0/1092
All	All	0.40	0/6642	0.63	0/9091

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	C	0	3
2	D	0	3
All	All	0	6

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 6 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	C	18	DG	Sidechain
1	C	20	DG	Sidechain
1	C	21	DA	Sidechain
2	D	5	DA	Sidechain
2	D	6	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	C	209	0	115	21	0
2	D	258	0	146	7	0
3	A	5251	0	5084	110	1
4	B	790	0	808	25	0
5	A	1	0	0	0	0
6	A	266	0	0	4	0
6	B	15	0	0	1	0
6	C	11	0	0	0	0
6	D	23	0	0	0	0
All	All	6824	0	6153	151	1

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 12.

The worst 5 of 151 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:C:22:2DT:H6	1:C:22:2DT:H5'	1.30	1.14
1:C:21:DA:H2''	1:C:22:2DT:H5''	1.22	1.12
3:A:271:THR:HG22	3:A:290:LYS:HG2	1.53	0.90
4:B:19:ALA:HB3	4:B:23:ILE:HD11	1.57	0.84
1:C:17:DT:H2''	1:C:18:DG:H5''	1.57	0.83

All (1) 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	Interatomic distance (Å)	Clash overlap (Å)
3:A:205:THR:OG1	3:A:687:ARG:NH2[2_655]	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	
3	A	669/698 (96%)	642 (96%)	25 (4%)	2 (0%)	43	43
4	B	103/108 (95%)	102 (99%)	1 (1%)	0	100	100
All	All	772/806 (96%)	744 (96%)	26 (3%)	2 (0%)	43	43

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	A	513	ALA
3	A	653	HIS

### 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	
3	A	527/579 (91%)	504 (96%)	23 (4%)	31	30
4	B	81/87 (93%)	77 (95%)	4 (5%)	27	25
All	All	608/666 (91%)	581 (96%)	27 (4%)	31	30

5 of 27 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	A	507	THR
3	A	547	ARG
4	B	89	THR
3	A	518	ARG

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Mol	Chain	Res	Type
3	A	174	ASP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 15 such sidechains are listed below:

Mol	Chain	Res	Type
3	A	347	GLN
3	A	423	ASN
3	A	510	GLN
3	A	343	GLN
3	A	502	ASN

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

2 non-standard protein/DNA/RNA residues 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
1	2DT	C	22	1,2	12,20,21	1.52	3 (25%)	11,28,31	4.61	3 (27%)
2	8FG	D	4	2	37,44,45	3.71	21 (56%)	51,66,69	2.18	14 (27%)

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
1	2DT	C	22	1,2	-	0/3/18/19	0/2/2/2
2	8FG	D	4	2	-	0/11/41/42	0/6/6/6

The worst 5 of 24 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	22	2DT	O5'-C5'	-3.14	1.40	1.44
2	D	4	8FG	C32-N29	-3.05	1.40	1.44
2	D	4	8FG	C39-C35	-2.67	1.39	1.46
1	C	22	2DT	C6-C5	-2.25	1.34	1.40
2	D	4	8FG	C42-C41	2.69	1.44	1.38

The worst 5 of 17 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	4	8FG	C5-C6-N1	-5.06	116.27	123.47
2	D	4	8FG	N3-C2-N1	-4.80	120.37	127.41
2	D	4	8FG	C32-N29-C8	-3.76	112.03	120.88
2	D	4	8FG	C6-C5-C4	-3.62	117.29	120.85
1	C	22	2DT	O4'-C4'-C5'	-3.09	104.59	109.59

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 9 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	C	22	2DT	7	0
2	D	4	8FG	2	0

## 5.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 1 ligands modelled in this entry, 1 is monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

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 [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

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	C	9/22 (40%)	0.29	1 (11%) 5 7	27, 33, 71, 86	0
2	D	11/26 (42%)	0.43	1 (9%) 9 12	19, 31, 63, 81	0
3	A	675/698 (96%)	0.36	40 (5%) 22 28	14, 29, 60, 76	0
4	B	105/108 (97%)	0.65	11 (10%) 6 8	25, 38, 55, 63	0
All	All	800/854 (93%)	0.40	53 (6%) 18 23	14, 31, 60, 86	0

The worst 5 of 53 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	A	532	ALA	7.5
3	A	294	VAL	6.9
3	A	586	VAL	4.7
3	A	298	PHE	4.6
4	B	103	LEU	4.2

### 6.2 Non-standard residues in protein, DNA, RNA chains [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, 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	B-factors(Å <sup>2</sup> )	Q<0.9
2	8FG	D	4	39/40	0.76	0.28	44,54,68,68	0
1	2DT	C	22	19/20	0.95	0.17	28,31,34,35	0

### 6.3 Carbohydrates [i](#)

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. 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	B-factors( $\text{\AA}^2$ )	Q<0.9
5	MG	A	3001	1/1	0.79	0.28	42,42,42,42	0

## 6.5 Other polymers

There are no such residues in this entry.