



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 29, 2020 – 03:50 pm BST

PDB ID : 2R9L  
Title : Polymerase Domain from Mycobacterium tuberculosis Ligase D in complex with DNA  
Authors : Brissett, N.C.; Fox, G.C.; Pitcher, R.S.; Doherty, A.J.  
Deposited on : 2007-09-13  
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](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  
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

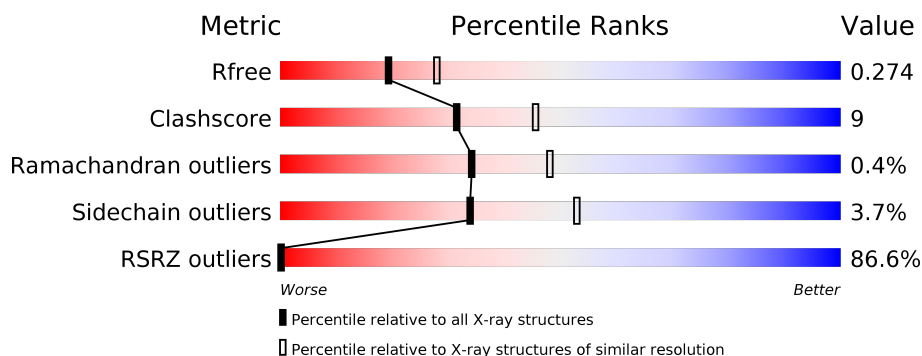
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.40 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))
$R_{free}$	130704	3907 (2.40-2.40)
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)
RSRZ outliers	127900	3811 (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  $\geq 3$ , 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	C	5	<div> <div>100%</div> <div>60% 40%</div> </div>
1	E	5	<div> <div>100%</div> <div>60% 20% 20%</div> </div>
2	D	11	<div> <div>73%</div> <div>73% 27%</div> </div>
3	F	13	<div> <div>92%</div> <div>54% 46%</div> </div>
4	A	303	<div> <div>80%</div> <div>76% 18% 5%</div> </div>
4	B	303	<div> <div>83%</div> <div>76% 14% 7%</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
5	EDO	B	293	-	-	-	X

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 5169 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 DNA (5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	C	5	Total	C	N	O	P	0	0	0
			105	48	21	31	5			
1	E	5	Total	C	N	O	P	0	0	0
			105	48	21	31	5			

- Molecule 2 is a DNA chain called DNA (5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DAP\*DCP\*DGP\*DCP\*DA)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	D	11	Total	C	N	O	P	0	0	0
			221	105	45	61	10			

- Molecule 3 is a DNA chain called DNA (5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DAP\*DCP\*DGP\*DCP\*DAP\*DCP\*DG)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	13	Total	C	N	O	P	0	0	0
			262	124	53	73	12			

- Molecule 4 is a protein called Putative DNA ligase-like protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	A	287	Total	C	N	O	S	19	0	0
			2193	1385	390	413	5			
4	B	282	Total	C	N	O	S	24	0	0
			2155	1363	384	403	5			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	GLY	-	EXPRESSION TAG	UNP P71571
A	-1	SER	-	EXPRESSION TAG	UNP P71571

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Chain	Residue	Modelled	Actual	Comment	Reference
A	0	HIS	-	EXPRESSION TAG	UNP P71571
B	-2	GLY	-	EXPRESSION TAG	UNP P71571
B	-1	SER	-	EXPRESSION TAG	UNP P71571
B	0	HIS	-	EXPRESSION TAG	UNP P71571

- Molecule 5 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C<sub>2</sub>H<sub>6</sub>O<sub>2</sub>).



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

- Molecule 6 is DI(HYDROXYETHYL)ETHER (three-letter code: PEG) (formula: C<sub>4</sub>H<sub>10</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			7	4	3		

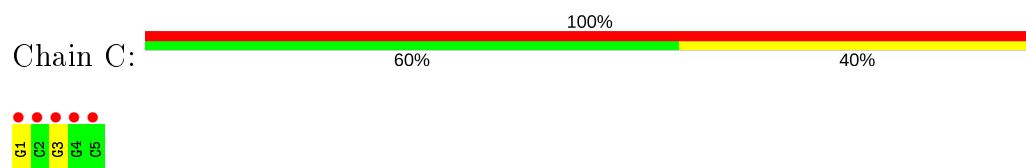
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	C	3	Total	O	0	0
			3	3		
7	D	5	Total	O	0	0
			5	5		
7	E	3	Total	O	0	0
			3	3		
7	F	3	Total	O	0	0
			3	3		
7	A	53	Total	O	0	0
			53	53		
7	B	30	Total	O	0	0
			30	30		

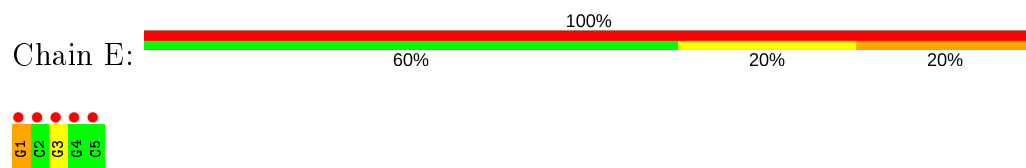
### 3 Residue-property plots [i](#)

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 ( $RSRZ > 2$ ). 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.

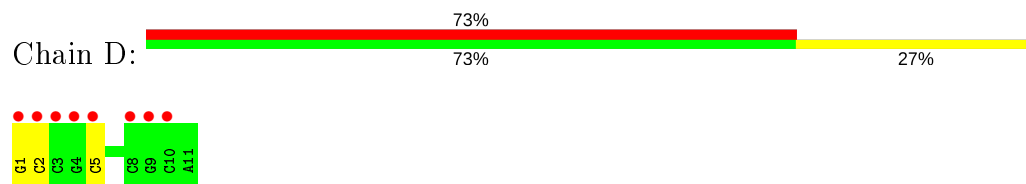
- Molecule 1: DNA (5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3')



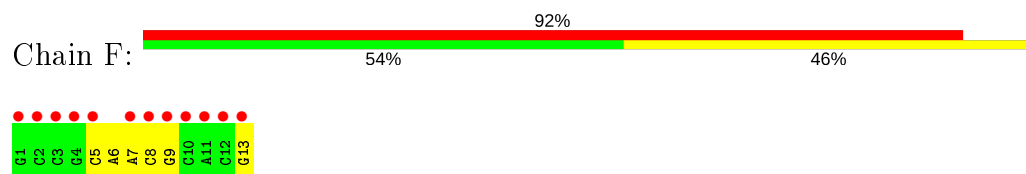
- Molecule 1: DNA (5'-D(P\*DGP\*DCP\*DGP\*DGP\*DC)-3')



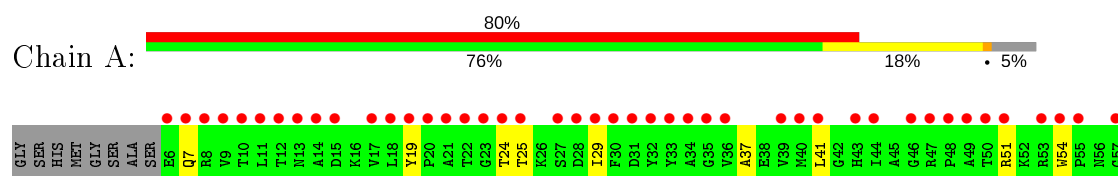
- Molecule 2: DNA (5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DAP\*DCP\*DGP\*DCP\*DA)-3')

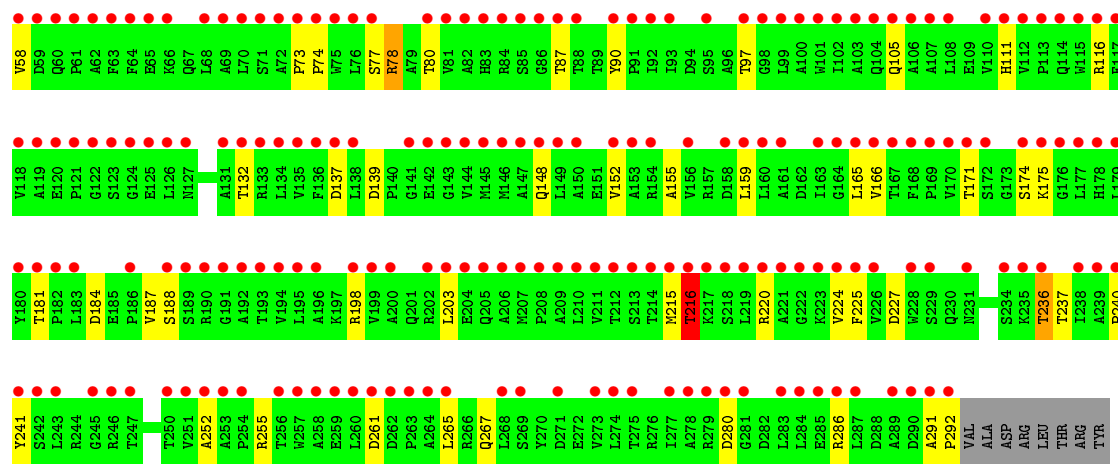


- Molecule 3: DNA (5'-D(\*DGP\*DCP\*DCP\*DGP\*DCP\*DAP\*DAP\*DCP\*DGP\*DCP\*DAP\*DCP\*DG)-3')

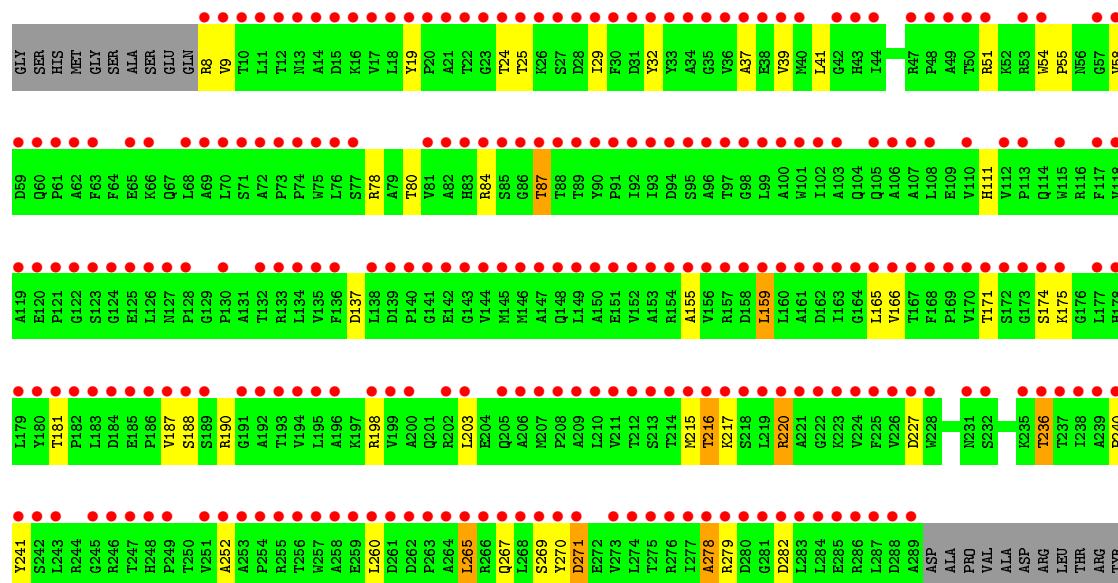
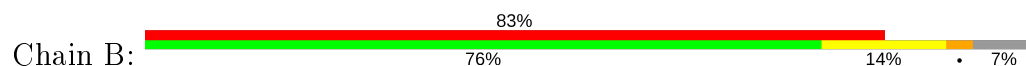


- Molecule 4: Putative DNA ligase-like protein





• Molecule 4: Putative DNA ligase-like protein





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	48.53Å 111.79Å 139.54Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	21.12 – 2.40 21.13 – 2.40	Depositor EDS
% Data completeness (in resolution range)	96.8 (21.12-2.40) 97.0 (21.13-2.40)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.02 (at 2.41Å)	Xtriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.227 , 0.272 0.231 , 0.274	Depositor DCC
$R_{free}$ test set	1502 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	46.6	Xtriage
Anisotropy	0.834	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 99.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	5169	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	90.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.69% 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: PEG, EDO

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	1.12	1/117 (0.9%)	1.40	2/177 (1.1%)
1	E	1.16	1/117 (0.9%)	1.34	2/177 (1.1%)
2	D	0.59	0/248	1.11	1/380 (0.3%)
3	F	0.58	0/294	1.15	3/451 (0.7%)
4	A	0.38	0/2244	0.53	0/3066
4	B	0.40	2/2205 (0.1%)	0.52	2/3012 (0.1%)
All	All	0.47	4/5225 (0.1%)	0.69	10/7263 (0.1%)

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	E	1	DG	OP3-P	-11.18	1.47	1.61
1	C	1	DG	OP3-P	-10.07	1.49	1.61
4	B	279	ARG	CZ-NH1	7.57	1.42	1.33
4	B	278	ALA	C-O	6.56	1.35	1.23

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	E	1	DG	OP1-P-OP2	-7.81	107.89	119.60
1	C	1	DG	OP1-P-OP2	-7.63	108.15	119.60
1	C	1	DG	O4'-C1'-N9	-7.28	102.91	108.00
2	D	5	DC	O4'-C1'-N1	7.17	113.02	108.00
3	F	9	DG	O4'-C1'-N9	-6.58	103.40	108.00

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	C	105	0	56	1	0
1	E	105	0	56	2	0
2	D	221	0	123	1	0
3	F	262	0	145	2	0
4	A	2193	0	2194	48	1
4	B	2155	0	2164	35	1
5	A	16	0	24	2	0
5	B	8	0	12	2	0
6	A	7	0	10	3	0
7	A	53	0	0	2	0
7	B	30	0	0	2	0
7	C	3	0	0	1	0
7	D	5	0	0	0	0
7	E	3	0	0	1	0
7	F	3	0	0	0	0
All	All	5169	0	4784	88	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 9.

The worst 5 of 88 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:116:ARG:NH2	4:A:291:ALA:HA	1.38	1.37
4:A:116:ARG:NH2	4:A:292:PRO:HD3	1.66	1.08
4:A:116:ARG:HH21	4:A:292:PRO:HD3	0.94	1.07
4:A:116:ARG:HH22	4:A:291:ALA:CA	1.75	0.97
4:A:198:ARG:NH2	6:A:297:PEG:O1	2.00	0.94

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)
4:A:184:ASP:OD2	4:B:198:ARG:NH1[3_544]	2.03	0.17

## 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	
4	A	285/303 (94%)	269 (94%)	15 (5%)	1 (0%)	34	48
4	B	280/303 (92%)	269 (96%)	10 (4%)	1 (0%)	34	48
All	All	565/606 (93%)	538 (95%)	25 (4%)	2 (0%)	34	48

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
4	B	216	THR
4	A	216	THR

### 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	230/242 (95%)	223 (97%)	7 (3%)	41	61
4	B	226/242 (93%)	216 (96%)	10 (4%)	28	45
All	All	456/484 (94%)	439 (96%)	17 (4%)	34	53

5 of 17 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	B	51	ARG
4	B	78	ARG
4	B	236	THR
4	A	280	ASP

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Mol	Chain	Res	Type
4	B	265	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
4	A	60	GLN
4	B	60	GLN
4	B	148	GLN

### 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](#)

7 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	$\# Z  > 2$
5	EDO	A	294	-	3,3,3	0.51	0	2,2,2	0.22	0
5	EDO	B	293	-	3,3,3	0.45	0	2,2,2	0.35	0
5	EDO	A	295	-	3,3,3	0.57	0	2,2,2	0.10	0
5	EDO	A	293	-	3,3,3	0.46	0	2,2,2	0.31	0
5	EDO	A	296	-	3,3,3	0.38	0	2,2,2	0.53	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
6	PEG	A	297	-	6,6,6	0.47	0	5,5,5	0.26	0
5	EDO	B	294	-	3,3,3	0.43	0	2,2,2	0.39	0

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
5	EDO	A	294	-	-	0/1/1/1	-
5	EDO	B	293	-	-	1/1/1/1	-
5	EDO	A	295	-	-	1/1/1/1	-
5	EDO	A	293	-	-	0/1/1/1	-
5	EDO	A	296	-	-	1/1/1/1	-
6	PEG	A	297	-	-	3/4/4/4	-
5	EDO	B	294	-	-	1/1/1/1	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 7 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	297	PEG	O2-C3-C4-O4
5	A	295	EDO	O1-C1-C2-O2
5	A	296	EDO	O1-C1-C2-O2
5	B	293	EDO	O1-C1-C2-O2
6	A	297	PEG	C4-C3-O2-C2

There are no ring outliers.

3 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	B	293	EDO	2	0
5	A	295	EDO	2	0
6	A	297	PEG	3	0

## 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 [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	5/5 (100%)	3.16	5 (100%) 0 0	89, 89, 89, 89	0
1	E	5/5 (100%)	4.24	5 (100%) 0 0	89, 89, 89, 89	0
2	D	11/11 (100%)	2.85	8 (72%) 0 0	84, 88, 91, 91	0
3	F	13/13 (100%)	3.53	12 (92%) 0 0	83, 90, 94, 94	0
4	A	287/303 (94%)	3.63	241 (83%) 0 0	83, 89, 100, 109	6 (2%)
4	B	282/303 (93%)	4.49	251 (89%) 0 0	82, 89, 96, 102	17 (6%)
All	All	603/640 (94%)	4.02	522 (86%) 0 0	82, 89, 98, 109	23 (3%)

The worst 5 of 522 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	B	258	ALA	15.3
4	B	29	ILE	12.2
4	B	281	GLY	11.9
4	B	263	PRO	11.4
4	A	121	PRO	10.8

### 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, 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
6	PEG	A	297	7/7	0.55	0.30	100,107,110,111	0
5	EDO	B	293	4/4	0.68	0.42	91,96,96,103	0
5	EDO	A	294	4/4	0.73	0.24	90,92,93,97	0
5	EDO	A	295	4/4	0.76	0.28	84,86,90,91	0
5	EDO	B	294	4/4	0.89	0.34	99,100,101,101	0
5	EDO	A	293	4/4	0.93	0.22	87,90,91,92	0
5	EDO	A	296	4/4	0.93	0.15	84,84,88,92	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.