



wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 14, 2017 – 12:46 am GMT

PDB ID : 4QWC
Title : TERNARY CRYSTAL STRUCTURES of A Y-FAMILY DNA POLYMERASE DPO4 FROM SULFOLOBUS SOLFATARICUS IN COMPLEX WITH DNA AND L-DCDP
Authors : Vyas, R.; Suo, Z.
Deposited on : 2014-07-16
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	:	1.7.2 (RC1), CSD as538be (2017)
Xtriage (Phenix)	:	1.9-1692
EDS	:	trunk28620
Percentile statistics	:	20161228.v01 (using entries in the PDB archive December 28th 2016)
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)	:	recalc28949

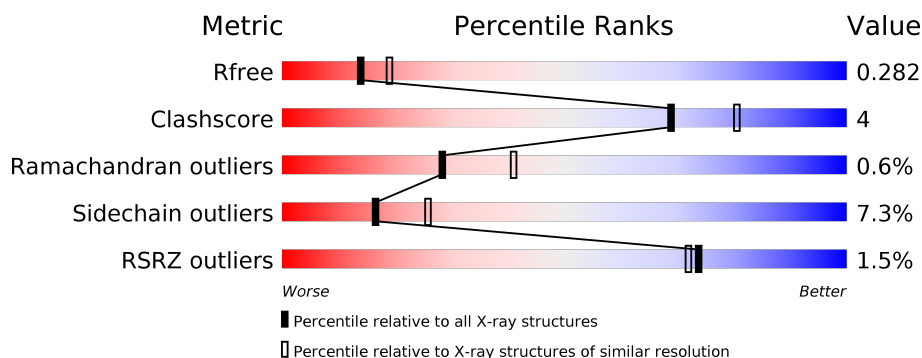
1 Overall quality at a glance ⓘ

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}	100719	3166 (2.40-2.40)
Clashscore	112137	3674 (2.40-2.40)
Ramachandran outliers	110173	3616 (2.40-2.40)
Sidechain outliers	110143	3617 (2.40-2.40)
RSRZ outliers	101464	3195 (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	A	343	<div> <div>2%</div> <div> <div></div> <div>85%</div> <div>13%</div> <div>.</div> </div> </div>
1	D	343	<div> <div>%</div> <div> <div></div> <div>87%</div> <div>10%</div> <div>.</div> </div> </div>
2	B	13	<div> <div></div> <div>46%</div> <div>46%</div> <div>8%</div> </div>
2	E	13	<div> <div></div> <div>62%</div> <div>31%</div> <div>8%</div> </div>
3	C	18	<div> <div></div> <div>61%</div> <div>22%</div> <div>17%</div> </div>
3	F	18	<div> <div></div> <div>50%</div> <div>33%</div> <div>17%</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	ACT	A	404	-	-	X	-
5	ACT	D	404	-	-	X	-
7	DOC	B	101	-	-	-	X

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 6888 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 protein called DNA polymerase IV.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	342	Total	C	N	O	S	0	0	0
			2752	1765	473	507	7			
1	D	342	Total	C	N	O	S	0	0	0
			2752	1765	473	507	7			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	343	ALA	-	EXPRESSION TAG	UNP Q97W02
D	343	ALA	-	EXPRESSION TAG	UNP Q97W02

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	12	Total	C	N	O	P	0	0	0
			245	117	48	69	11			
2	E	12	Total	C	N	O	P	0	0	0
			245	117	48	69	11			

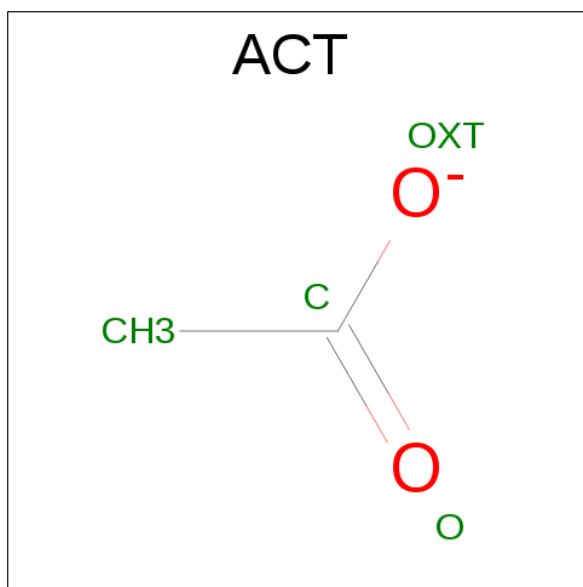
- Molecule 3 is a DNA chain called DNA (5'-D(*TP*TP*CP*AP*GP*GP*AP*GP*TP*CP*CP*TP*GP*TP*AP*GP*CP*C)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	15	Total	C	N	O	P	0	0	0
			309	146	58	90	15			
3	F	15	Total	C	N	O	P	0	0	0
			309	146	58	90	15			

- Molecule 4 is CALCIUM ION (three-letter code: CA) (formula: Ca).

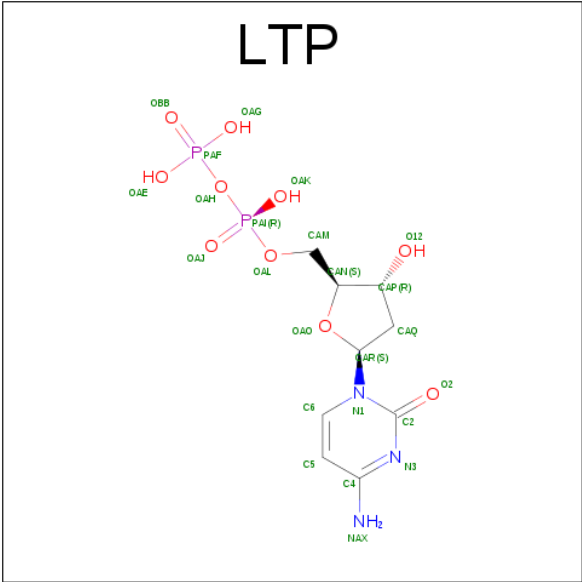
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	2	Total Ca 2 2	0	0
4	D	3	Total Ca 3 3	0	0

- Molecule 5 is ACETATE ION (three-letter code: ACT) (formula: $C_2H_3O_2$).



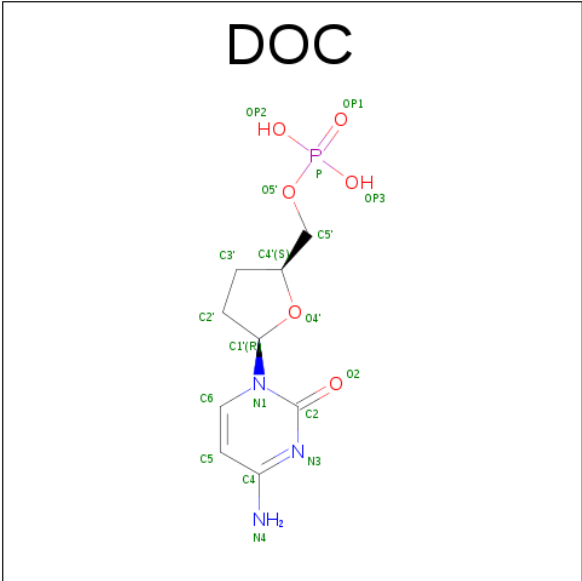
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	1	Total C O 4 2 2	0	0
5	A	1	Total C O 4 2 2	0	0
5	D	1	Total C O 4 2 2	0	0

- Molecule 6 is 4-AMINO-1-{2-DEOXY-5-O-[(R)-HYDROXY(PHOSPHONOOXY)PHOSPHORYL]-BETA-L-ERYTHRO-PENTOFURANOSYL}PYRIMIDIN-2(1H)-ONE (three-letter code: LTP) (formula: $C_9H_{15}N_3O_{10}P_2$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
6	A	1	Total	C	N	O	P	0	0
			24	9	3	10	2		
6	D	1	Total	C	N	O	P	0	0
			24	9	3	10	2		

- Molecule 7 is 2',3'-DIDEOXYCYTIDINE-5'-MONOPHOSPHATE (three-letter code: DOC) (formula: C₉H₁₄N₃O₆P).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
7	B	1	Total	C	N	O	P	0	0
			18	9	3	5	1		

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
7	E	1	Total	C	N	O	P	0	0
			18	9	3	5	1		

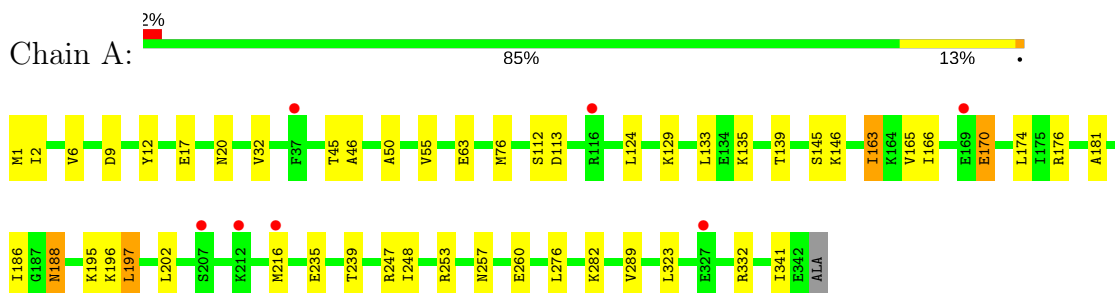
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	80	Total	O	0	0
			80	80		
8	B	9	Total	O	0	0
			9	9		
8	D	57	Total	O	0	0
			57	57		
8	E	5	Total	O	0	0
			5	5		
8	F	10	Total	O	0	0
			10	10		
8	C	14	Total	O	0	0
			14	14		

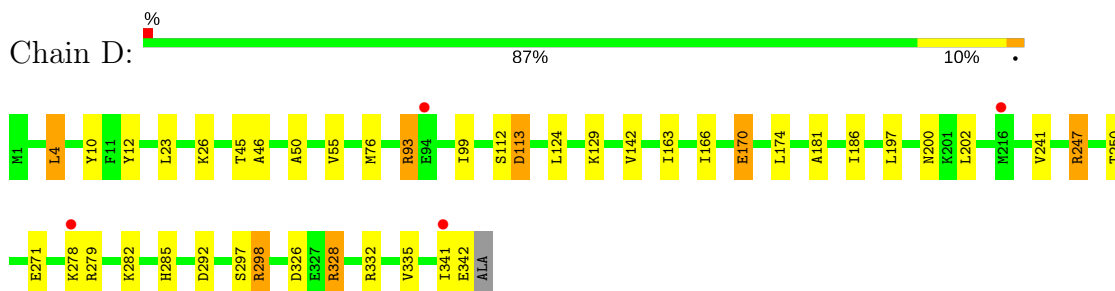
3 Residue-property plots [i](#)

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.

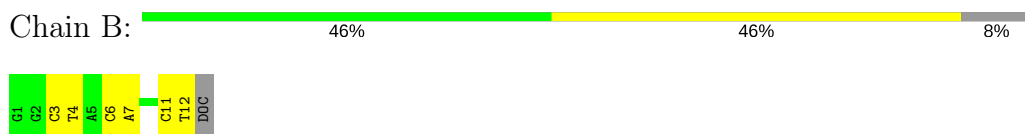
- Molecule 1: DNA polymerase IV



- Molecule 1: DNA polymerase IV



- Molecule 2: DNA (5'-D(*GP*GP*CP*TP*AP*CP*AP*GP*GP*AP*CP*TP*C)-3')



- Molecule 2: DNA (5'-D(*GP*GP*CP*TP*AP*CP*AP*GP*GP*AP*CP*TP*C)-3')



- Molecule 3: DNA (5'-D(*TP*TP*CP*AP*GP*GP*AP*GP*TP*CP*CP*TP*GP*TP*AP*GP*CP*C)-3')

Chain C:  61% 22% 17%



- Molecule 3: DNA (5'-D(*TP*TP*CP*AP*GP*GP*AP*GP*TP*CP*CP*TP*GP*TP*AP*GP*CP*C)-3')

Chain F:  50% 33% 17%



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	98.44Å 101.93Å 105.40Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	46.46 – 2.40 46.46 – 2.40	Depositor EDS
% Data completeness (in resolution range)	99.2 (46.46-2.40) 99.2 (46.46-2.40)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.50 (at 2.39Å)	Xtriage
Refinement program	REFMAC 5.8.0049	Depositor
R, R_{free}	0.227 , 0.277 0.233 , 0.282	Depositor DCC
R_{free} test set	2110 reflections (5.32%)	DCC
Wilson B-factor (Å ²)	58.0	Xtriage
Anisotropy	0.085	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 47.9	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.000 for -h,l,k	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	6888	wwPDB-VP
Average B, all atoms (Å ²)	70.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 73.34 % of the origin peak, indicating pseudo translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo translational symmetry is equal to 1.8724e-06. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

¹Intensities estimated from amplitudes.

²Theoretical 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: DOC, CA, LTP, ACT

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	0.45	0/2791	0.65	0/3748
1	D	0.41	0/2791	0.64	0/3748
2	B	0.35	0/275	0.77	0/423
2	E	0.32	0/275	0.81	0/423
3	C	0.41	0/346	0.85	1/532 (0.2%)
3	F	0.35	0/346	0.84	0/532
All	All	0.42	0/6824	0.69	1/9406 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	8	DG	C1'-O4'-C4'	-5.08	105.02	110.10

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	A	2752	0	2895	21	0
1	D	2752	0	2895	19	0
2	B	245	0	135	7	0
2	E	245	0	135	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	C	309	0	169	2	0
3	F	309	0	169	4	0
4	A	2	0	0	0	0
4	D	3	0	0	0	0
5	A	8	0	6	3	0
5	D	4	0	3	3	0
6	A	24	0	14	1	0
6	D	24	0	14	0	0
7	B	18	0	12	2	0
7	E	18	0	12	1	0
8	A	80	0	0	5	0
8	B	9	0	0	0	0
8	C	14	0	0	0	0
8	D	57	0	0	3	0
8	E	5	0	0	1	0
8	F	10	0	0	1	0
All	All	6888	0	6459	57	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 4.

The worst 5 of 57 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)
6:A:405:LTP:OBB	8:A:559:HOH:O	1.84	0.94
2:E:4:DT:H2''	2:E:5:DA:H5''	1.52	0.89
2:B:12:DT:H2'	7:B:101:DOC:O4'	1.85	0.77
1:A:181:ALA:O	5:A:404:ACT:C	2.37	0.73
7:E:101:DOC:H2''	8:E:204:HOH:O	1.90	0.71

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	
1	A	340/343 (99%)	328 (96%)	10 (3%)	2 (1%)	28	41
1	D	340/343 (99%)	328 (96%)	10 (3%)	2 (1%)	28	41
All	All	680/686 (99%)	656 (96%)	20 (3%)	4 (1%)	28	41

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	196	LYS
1	A	197	LEU
1	D	292	ASP
1	D	113	ASP

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	
1	A	301/301 (100%)	279 (93%)	22 (7%)	16	26
1	D	301/301 (100%)	279 (93%)	22 (7%)	16	26
All	All	602/602 (100%)	558 (93%)	44 (7%)	16	26

5 of 44 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	253	ARG
1	D	26	LYS
1	D	297	SER
1	A	276	LEU
1	D	4	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	20	ASN
1	D	20	ASN

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 12 ligands modelled in this entry, 5 are monoatomic - leaving 7 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	$\# Z > 2$
5	ACT	A	403	-	1,3,3	2.10	1 (100%)	0,3,3	0.00	-
5	ACT	A	404	-	1,3,3	1.60	0	0,3,3	0.00	-
6	LTP	A	405	4	21,25,25	2.33	3 (14%)	24,38,38	1.60	3 (12%)
7	DOC	B	101	2	13,19,20	0.66	0	12,26,29	1.40	1 (8%)
5	ACT	D	404	-	1,3,3	1.07	0	0,3,3	0.00	-
6	LTP	D	405	4	21,25,25	2.15	2 (9%)	24,38,38	1.35	4 (16%)
7	DOC	E	101	2	13,19,20	0.76	0	12,26,29	1.69	5 (41%)

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	ACT	A	403	-	-	0/0/0/0	0/0/0/0
5	ACT	A	404	-	-	0/0/0/0	0/0/0/0
6	LTP	A	405	4	-	0/12/28/28	0/2/2/2
7	DOC	B	101	2	-	0/3/18/19	0/2/2/2
5	ACT	D	404	-	-	0/0/0/0	0/0/0/0
6	LTP	D	405	4	-	0/12/28/28	0/2/2/2
7	DOC	E	101	2	-	0/3/18/19	0/2/2/2

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	405	LTP	C2-N3	-2.43	1.33	1.38
5	A	403	ACT	CH3-C	2.10	1.51	1.48
6	D	405	LTP	C6-C5	3.97	1.46	1.38
6	A	405	LTP	C6-C5	4.08	1.46	1.38
6	D	405	LTP	C6-N1	8.48	1.47	1.35

The worst 5 of 13 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	A	405	LTP	CAQ-CAR-N1	-4.28	104.13	114.23
6	A	405	LTP	C5-C6-N1	-3.38	112.93	120.67
6	D	405	LTP	C5-C6-N1	-3.16	113.44	120.67
6	D	405	LTP	CAQ-CAR-N1	-3.11	106.90	114.23
6	D	405	LTP	NAX-C4-N3	2.07	120.13	116.64

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	404	ACT	3	0
6	A	405	LTP	1	0
7	B	101	DOC	2	0
5	D	404	ACT	3	0
7	E	101	DOC	1	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, 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	A	342/343 (99%)	0.24	7 (2%) 65 63	28, 61, 89, 112	0
1	D	342/343 (99%)	0.32	4 (1%) 79 77	35, 69, 103, 124	0
2	B	12/13 (92%)	0.15	0 100 100	55, 69, 92, 92	0
2	E	12/13 (92%)	0.41	0 100 100	74, 87, 94, 98	0
3	C	15/18 (83%)	0.11	0 100 100	53, 74, 90, 139	0
3	F	15/18 (83%)	0.37	0 100 100	64, 95, 117, 149	0
All	All	738/748 (98%)	0.27	11 (1%) 74 72	28, 66, 101, 149	0

The worst 5 of 11 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	212	LYS	3.5
1	A	116	ARG	2.6
1	D	216	MET	2.5
1	D	341	ILE	2.4
1	A	207	SER	2.4

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, 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
7	DOC	B	101	18/19	0.88	0.26	5.90	75,82,88,88	4
5	ACT	A	404	4/4	0.86	0.18	0.58	42,46,46,52	0
6	LTP	D	405	24/24	0.92	0.19	0.18	58,65,70,71	0
7	DOC	E	101	18/19	0.92	0.17	0.05	77,84,91,92	0
6	LTP	A	405	24/24	0.95	0.17	-0.04	47,57,73,79	0
4	CA	A	401	1/1	0.98	0.11	-2.36	43,43,43,43	0
4	CA	A	402	1/1	0.79	0.12	-3.26	88,88,88,88	0
4	CA	D	403	1/1	0.99	0.10	-4.36	52,52,52,52	0
4	CA	D	402	1/1	0.81	0.10	-9.01	86,86,86,86	0
5	ACT	A	403	4/4	0.82	0.31	-	78,83,84,85	0
5	ACT	D	404	4/4	0.97	0.17	-	59,62,64,65	0
4	CA	D	401	1/1	0.89	0.09	-	96,96,96,96	0

6.5 Other polymers [i](#)

There are no such residues in this entry.