



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 17, 2016 – 09:27 AM EDT

PDB ID : 4YTT
Title : Crystal structure of D-tagatose 3-epimerase C66S from *Pseudomonas cichorii*
in complex with 6-deoxy L-psicose
Authors : Yoshida, H.; Yoshihara, A.; Ishii, T.; Izumori, K.; Kamitori, S.
Deposited on : 2015-03-18
Resolution : 1.80 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 : 1.7.1 (RC1), CSD as537be (2016)
Xtriage (Phenix) : 1.9-1692
EDS : rb-20027107
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac : 5.8.0122
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20027107

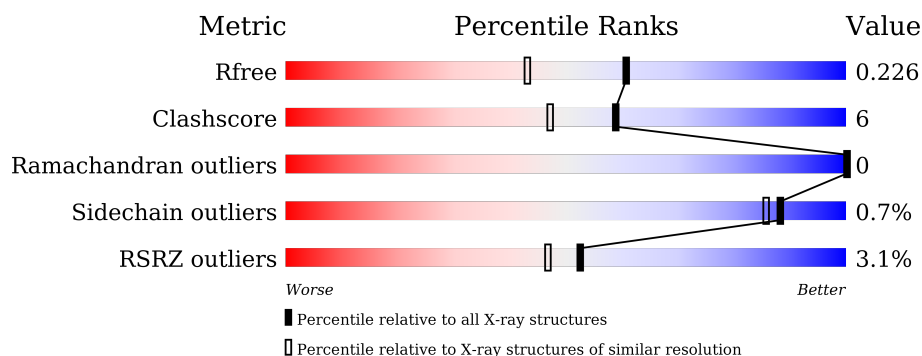
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.80 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	4533 (1.80-1.80)
Clashscore	102246	5383 (1.80-1.80)
Ramachandran outliers	100387	5320 (1.80-1.80)
Sidechain outliers	100360	5319 (1.80-1.80)
RSRZ outliers	91569	4547 (1.80-1.80)

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	300	 2% 88% 9% ..
1	B	300	 2% 84% 12% ..
1	C	300	 3% 89% 10% ..
1	D	300	 5% 81% 16% .

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
3	PUD	A	402[A]	-	-	-	X
3	PUD	A	402[B]	-	-	-	X
3	PUD	B	402	-	-	-	X
3	PUD	C	402	-	-	-	X
3	PUD	D	402	-	-	-	X
4	PUF	A	403	-	-	-	X
4	PUF	B	403	-	-	-	X
4	PUF	D	403	-	-	-	X

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 10678 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 D-tagatose 3-epimerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	294	Total	C	N	O	S	0	0	0
			2314	1465	399	432	18			
1	B	290	Total	C	N	O	S	0	0	0
			2287	1451	392	426	18			
1	C	297	Total	C	N	O	S	0	0	0
			2344	1483	408	435	18			
1	D	292	Total	C	N	O	S	0	0	0
			2297	1456	394	429	18			

There are 44 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	66	SER	CYS	engineered mutation	UNP O50580
A	291	GLY	-	expression tag	UNP O50580
A	292	SER	-	expression tag	UNP O50580
A	293	ARG	-	expression tag	UNP O50580
A	294	SER	-	expression tag	UNP O50580
A	295	HIS	-	expression tag	UNP O50580
A	296	HIS	-	expression tag	UNP O50580
A	297	HIS	-	expression tag	UNP O50580
A	298	HIS	-	expression tag	UNP O50580
A	299	HIS	-	expression tag	UNP O50580
A	300	HIS	-	expression tag	UNP O50580
B	66	SER	CYS	engineered mutation	UNP O50580
B	291	GLY	-	expression tag	UNP O50580
B	292	SER	-	expression tag	UNP O50580
B	293	ARG	-	expression tag	UNP O50580
B	294	SER	-	expression tag	UNP O50580
B	295	HIS	-	expression tag	UNP O50580
B	296	HIS	-	expression tag	UNP O50580
B	297	HIS	-	expression tag	UNP O50580
B	298	HIS	-	expression tag	UNP O50580
B	299	HIS	-	expression tag	UNP O50580

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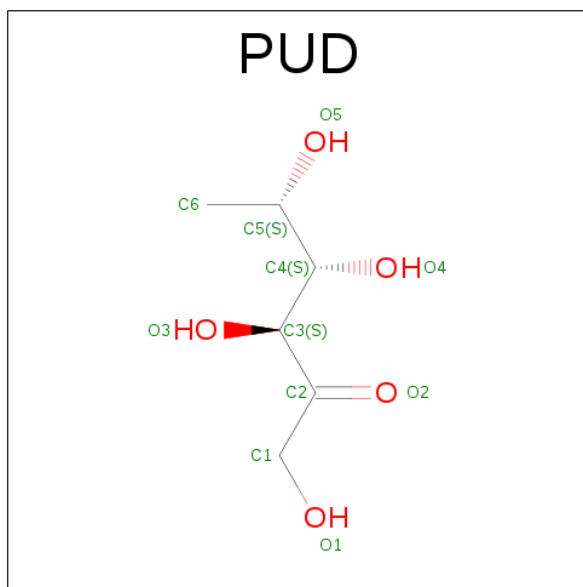
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Chain	Residue	Modelled	Actual	Comment	Reference
B	300	HIS	-	expression tag	UNP O50580
C	66	SER	CYS	engineered mutation	UNP O50580
C	291	GLY	-	expression tag	UNP O50580
C	292	SER	-	expression tag	UNP O50580
C	293	ARG	-	expression tag	UNP O50580
C	294	SER	-	expression tag	UNP O50580
C	295	HIS	-	expression tag	UNP O50580
C	296	HIS	-	expression tag	UNP O50580
C	297	HIS	-	expression tag	UNP O50580
C	298	HIS	-	expression tag	UNP O50580
C	299	HIS	-	expression tag	UNP O50580
C	300	HIS	-	expression tag	UNP O50580
D	66	SER	CYS	engineered mutation	UNP O50580
D	291	GLY	-	expression tag	UNP O50580
D	292	SER	-	expression tag	UNP O50580
D	293	ARG	-	expression tag	UNP O50580
D	294	SER	-	expression tag	UNP O50580
D	295	HIS	-	expression tag	UNP O50580
D	296	HIS	-	expression tag	UNP O50580
D	297	HIS	-	expression tag	UNP O50580
D	298	HIS	-	expression tag	UNP O50580
D	299	HIS	-	expression tag	UNP O50580
D	300	HIS	-	expression tag	UNP O50580

- Molecule 2 is MANGANESE (II) ION (three-letter code: MN) (formula: Mn).

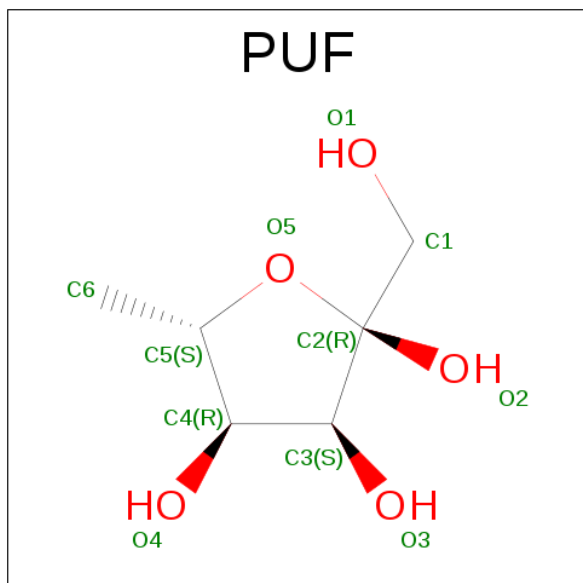
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	B	1	Total Mn 1 1	0	0
2	A	1	Total Mn 1 1	0	0
2	D	1	Total Mn 1 1	0	0
2	C	1	Total Mn 1 1	0	0

- Molecule 3 is 6-deoxy-L-psicose (three-letter code: PUD) (formula: C₆H₁₂O₅).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	1
			13	7	6		
3	B	1	Total	C	O	0	0
			11	6	5		
3	C	1	Total	C	O	0	0
			11	6	5		
3	D	1	Total	C	O	0	0
			11	6	5		

- Molecule 4 is 6-deoxy-alpha-L-psicofuranose (three-letter code: PUF) (formula: $C_6H_{12}O_5$).


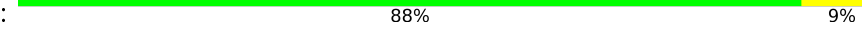



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			11	6	5		
4	B	1	Total	C	O	0	0
			11	6	5		
4	D	1	Total	C	O	0	0
			11	6	5		


- Molecule 5 is water.

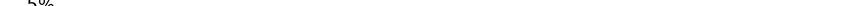
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	364	Total	O	0	0
			364	364		
5	B	346	Total	O	0	0
			346	346		
5	C	383	Total	O	0	0
			383	383		
5	D	260	Total	O	0	0
			260	260		

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 ($\text{RSRZ} > 2$). 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.

- Chain A:  88% 9% 2%
- 
- 

- Chain B:
-
- 84% 12% 2%
- M1 M2 K3 V4 R50 K53 T62 S66 I67 G68 L99 A106 P117 P118 L119 D120 K121 K122 R125 P126 I139 V153 W160 A168 S177 V182 Q183 F187 T194 F210 F211 L212 R217 D240 I243 E246 P248 F248 W260 V259 G260 V261 M265 E272 R277 A290 GLY SER ARG SER HIS HIS HIS HIS HIS

- Chain C: 

- Chain D: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	52.40Å 126.73Å 99.34Å 90.00° 101.71° 90.00°	Depositor
Resolution (Å)	23.42 – 1.80 23.41 – 1.80	Depositor EDS
% Data completeness (in resolution range)	97.1 (23.42-1.80) 97.3 (23.41-1.80)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.15 (at 1.80Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.190 , 0.226 0.190 , 0.226	Depositor DCC
R_{free} test set	11409 reflections (10.01%)	DCC
Wilson B-factor (Å ²)	23.1	Xtriage
Anisotropy	0.327	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 42.2	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning ²	$\langle L \rangle = 0.51$, $\langle L^2 \rangle = 0.34$	Xtriage
Outliers	1 of 113995 reflections (0.001%)	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	10678	wwPDB-VP
Average B, all atoms (Å ²)	24.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.41% 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: PUD, PUF, MN

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	0.32	0/2365	0.59	1/3190 (0.0%)
1	B	0.33	0/2338	0.59	1/3155 (0.0%)
1	C	0.32	0/2398	0.59	1/3235 (0.0%)
1	D	0.30	0/2348	0.56	0/3168
All	All	0.32	0/9449	0.58	3/12748 (0.0%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	68	GLY	N-CA-C	-5.91	98.33	113.10
1	A	68	GLY	N-CA-C	-5.44	99.50	113.10
1	C	68	GLY	N-CA-C	-5.42	99.55	113.10

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

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	2314	0	2271	17	0
1	B	2287	0	2245	33	0
1	C	2344	0	2292	24	0
1	D	2297	0	2253	36	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	A	13	0	0	0	0
3	B	11	0	0	0	0
3	C	11	0	0	0	0
3	D	11	0	0	0	0
4	A	11	0	0	0	0
4	B	11	0	0	0	0
4	D	11	0	0	0	0
5	A	364	0	0	0	0
5	B	346	0	0	0	0
5	C	383	0	0	1	0
5	D	260	0	0	2	0
All	All	10678	0	9061	107	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 6.

The worst 5 of 107 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:118:PRO:HG2	1:C:121:MET:HB2	1.60	0.81
1:B:212:LEU:HG	1:B:243:ILE:HD11	1.67	0.76
1:A:216:ASN:HD21	1:B:194:THR:HG22	1.54	0.72
1:A:106:ALA:HB1	1:A:183:GLN:OE1	1.93	0.69
1:D:3:LYS:HE3	1:D:62:THR:HG21	1.75	0.67

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	292/300 (97%)	288 (99%)	4 (1%)	0	100	100
1	B	288/300 (96%)	284 (99%)	4 (1%)	0	100	100
1	C	295/300 (98%)	291 (99%)	4 (1%)	0	100	100
1	D	290/300 (97%)	283 (98%)	7 (2%)	0	100	100
All	All	1165/1200 (97%)	1146 (98%)	19 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	
1	A	243/249 (98%)	241 (99%)	2 (1%)	86	83
1	B	240/249 (96%)	238 (99%)	2 (1%)	86	83
1	C	246/249 (99%)	243 (99%)	3 (1%)	78	71
1	D	241/249 (97%)	241 (100%)	0	100	100
All	All	970/996 (97%)	963 (99%)	7 (1%)	88	86

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

Mol	Chain	Res	Type
1	B	122	LYS
1	C	201	LEU
1	C	58	ASP
1	A	267	ASN
1	C	79	ASP

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 6 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	43	ASN
1	D	267	ASN
1	C	267	ASN

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Mol	Chain	Res	Type
1	A	267	ASN
1	C	296	HIS

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, 4 are monoatomic - leaving 8 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	$\# Z > 2$
3	PUD	A	402[A]	-	9,10,10	0.35	0	8,13,13	0.68	0
3	PUD	A	402[B]	-	9,10,10	0.36	0	8,13,13	0.67	0
4	PUF	A	403	-	10,11,11	0.43	0	10,17,17	1.36	2 (20%)
3	PUD	B	402	2	9,10,10	0.37	0	8,13,13	0.87	0
4	PUF	B	403	-	10,11,11	0.41	0	10,17,17	1.41	2 (20%)
3	PUD	C	402	2	9,10,10	0.39	0	8,13,13	0.86	0
3	PUD	D	402	2	9,10,10	0.37	0	8,13,13	0.87	0
4	PUF	D	403	-	10,11,11	0.44	0	10,17,17	1.42	2 (20%)

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
3	PUD	A	402[A]	-	-	0/14/14/14	0/0/0/0
3	PUD	A	402[B]	-	-	0/14/14/14	0/0/0/0
4	PUF	A	403	-	-	0/3/22/22	0/1/1/1
3	PUD	B	402	2	-	0/14/14/14	0/0/0/0
4	PUF	B	403	-	-	0/3/22/22	0/1/1/1
3	PUD	C	402	2	-	0/14/14/14	0/0/0/0
3	PUD	D	402	2	-	0/14/14/14	0/0/0/0
4	PUF	D	403	-	-	0/3/22/22	0/1/1/1

There are no bond length outliers.

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	403	PUF	C6-C5-C4	-2.62	112.87	115.81
4	D	403	PUF	C6-C5-C4	-2.50	113.01	115.81
4	A	403	PUF	C6-C5-C4	-2.43	113.09	115.81
4	A	403	PUF	O5-C5-C4	2.78	106.87	102.96
4	B	403	PUF	O5-C5-C4	2.80	106.90	102.96

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, 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	294/300 (98%)	-0.16	6 (2%) 68 64	15, 20, 30, 51	0
1	B	290/300 (96%)	-0.14	6 (2%) 67 62	15, 20, 29, 48	0
1	C	297/300 (99%)	-0.09	9 (3%) 54 48	15, 20, 29, 50	0
1	D	292/300 (97%)	0.36	15 (5%) 32 26	17, 27, 43, 61	0
All	All	1173/1200 (97%)	-0.01	36 (3%) 52 47	15, 21, 37, 61	0

The worst 5 of 36 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	1	MET	9.2
1	D	292	SER	9.0
1	B	1	MET	5.4
1	A	294	SER	4.7
1	A	1	MET	4.5

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(\AA^2)	Q<0.9
4	PUF	A	403	11/11	0.81	0.15	13.17	29,31,32,35	0
3	PUD	A	402[B]	11/11	0.61	0.26	9.63	31,42,45,48	2
3	PUD	A	402[A]	11/11	0.61	0.26	9.63	31,42,45,48	2
4	PUF	D	403	11/11	0.68	0.25	8.00	38,40,40,41	0
3	PUD	B	402	11/11	0.77	0.21	7.83	32,43,49,50	0
4	PUF	B	403	11/11	0.83	0.14	5.26	28,31,33,34	0
3	PUD	C	402	11/11	0.73	0.19	5.09	28,41,44,49	0
3	PUD	D	402	11/11	0.73	0.22	4.38	40,47,49,51	0
2	MN	C	401	1/1	1.00	0.04	-3.36	26,26,26,26	0
2	MN	A	401	1/1	1.00	0.04	-3.70	22,22,22,22	0
2	MN	D	401	1/1	0.99	0.03	-3.86	25,25,25,25	0
2	MN	B	401	1/1	1.00	0.06	-4.13	25,25,25,25	0

6.5 Other polymers [i](#)

There are no such residues in this entry.