



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 8, 2026 – 08:58 AM UTC

PDB ID : 2FJK / pdb_00002fjk
Title : Crystal structure of Fructose-1,6-Bisphosphate Aldolase in *Thermus caldophilus*
Authors : Lee, J.H.; Im, Y.J.; Rho, S.-H.; Kim, M.-K.; Kang, G.B.; Eom, S.H.
Deposited on : 2006-01-03
Resolution : 2.20 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

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

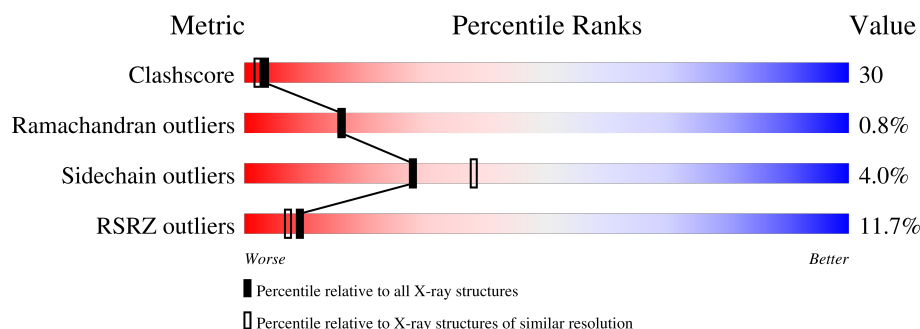
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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))
Clashscore	190562	6851 (2.20-2.20)
Ramachandran outliers	187476	6768 (2.20-2.20)
Sidechain outliers	187428	6769 (2.20-2.20)
RSRZ outliers	180081	6166 (2.20-2.20)

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 of the lower bar indicate the fraction of residues that contain outliers for ≥ 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	A	305	11% 53% 43% 5%
1	B	305	7% 56% 37% • •
1	C	305	12% 54% 41% • •
1	D	305	15% 50% 42% • 5%

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
2	13P	A	1063	-	-	X	-
2	13P	C	1083	-	-	X	-
2	13P	D	1093	-	-	X	-

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 9340 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 Fructose-bisphosphate aldolase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	305	Total	C	N	O	Se	0	0	0
			2320	1459	417	436	8			
1	B	298	Total	C	N	O	Se	0	0	0
			2265	1426	408	423	8			
1	C	299	Total	C	N	O	Se	0	0	0
			2274	1431	409	426	8			
1	D	290	Total	C	N	O	Se	0	0	0
			2209	1391	399	411	8			

There are 32 discrepancies between the modelled and reference sequences:

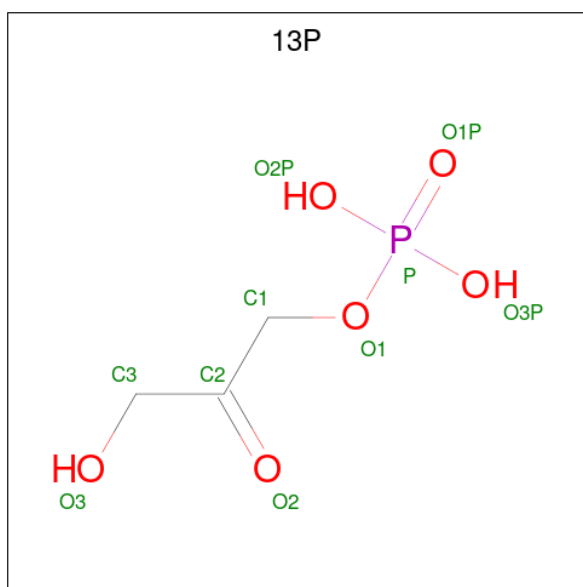
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	MSE	MET	modified residue	UNP Q703I2
A	27	MSE	MET	modified residue	UNP Q703I2
A	40	MSE	MET	modified residue	UNP Q703I2
A	53	MSE	MET	modified residue	UNP Q703I2
A	63	MSE	MET	modified residue	UNP Q703I2
A	100	MSE	MET	modified residue	UNP Q703I2
A	162	MSE	MET	modified residue	UNP Q703I2
A	296	MSE	MET	modified residue	UNP Q703I2
B	1	MSE	MET	modified residue	UNP Q703I2
B	27	MSE	MET	modified residue	UNP Q703I2
B	40	MSE	MET	modified residue	UNP Q703I2
B	53	MSE	MET	modified residue	UNP Q703I2
B	63	MSE	MET	modified residue	UNP Q703I2
B	100	MSE	MET	modified residue	UNP Q703I2
B	162	MSE	MET	modified residue	UNP Q703I2
B	296	MSE	MET	modified residue	UNP Q703I2
C	1	MSE	MET	modified residue	UNP Q703I2
C	27	MSE	MET	modified residue	UNP Q703I2
C	40	MSE	MET	modified residue	UNP Q703I2
C	53	MSE	MET	modified residue	UNP Q703I2
C	63	MSE	MET	modified residue	UNP Q703I2

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Chain	Residue	Modelled	Actual	Comment	Reference
C	100	MSE	MET	modified residue	UNP Q703I2
C	162	MSE	MET	modified residue	UNP Q703I2
C	296	MSE	MET	modified residue	UNP Q703I2
D	1	MSE	MET	modified residue	UNP Q703I2
D	27	MSE	MET	modified residue	UNP Q703I2
D	40	MSE	MET	modified residue	UNP Q703I2
D	53	MSE	MET	modified residue	UNP Q703I2
D	63	MSE	MET	modified residue	UNP Q703I2
D	100	MSE	MET	modified residue	UNP Q703I2
D	162	MSE	MET	modified residue	UNP Q703I2
D	296	MSE	MET	modified residue	UNP Q703I2

- Molecule 2 is 1,3-DIHYDROXYACETONEPHOSPHATE (CCD ID: 13P) (formula: $C_3H_7O_6P$).



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

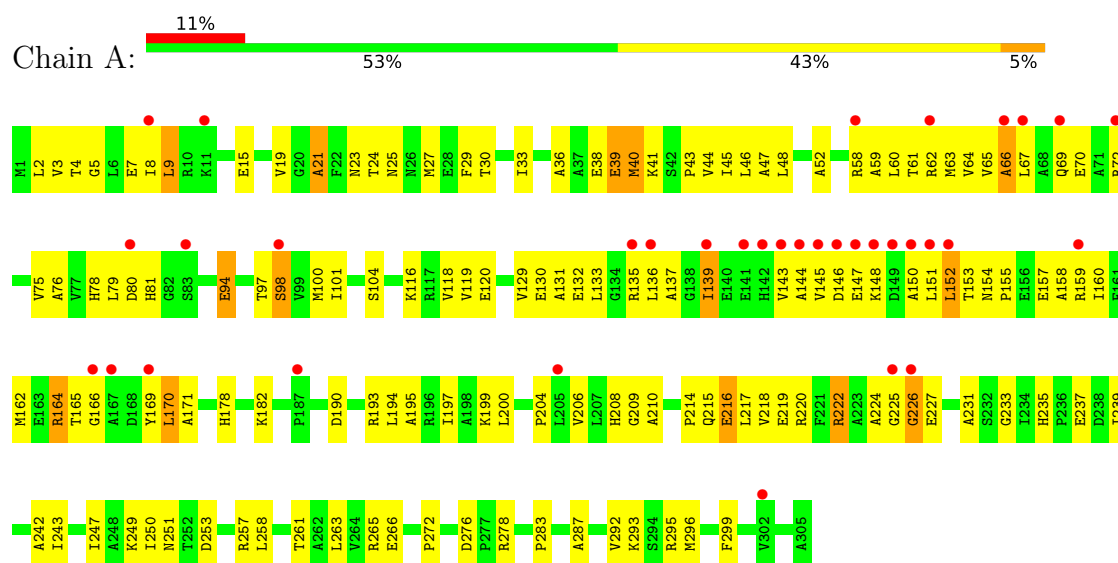
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	47	Total 47	O 47	0	0
3	B	91	Total 91	O 91	0	0
3	C	67	Total 67	O 67	0	0
3	D	27	Total 27	O 27	0	0

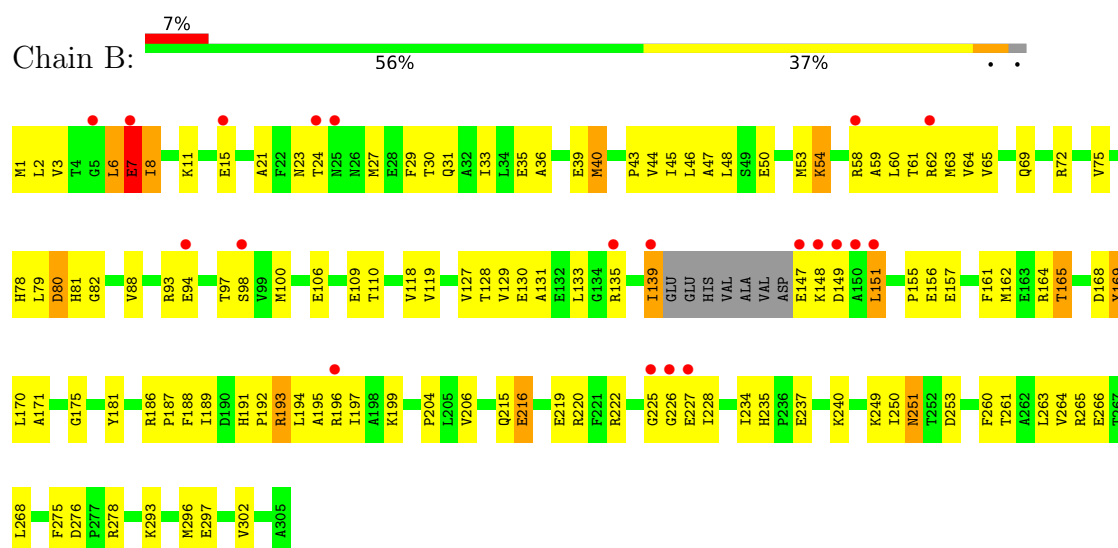
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide 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: Fructose-bisphosphate aldolase

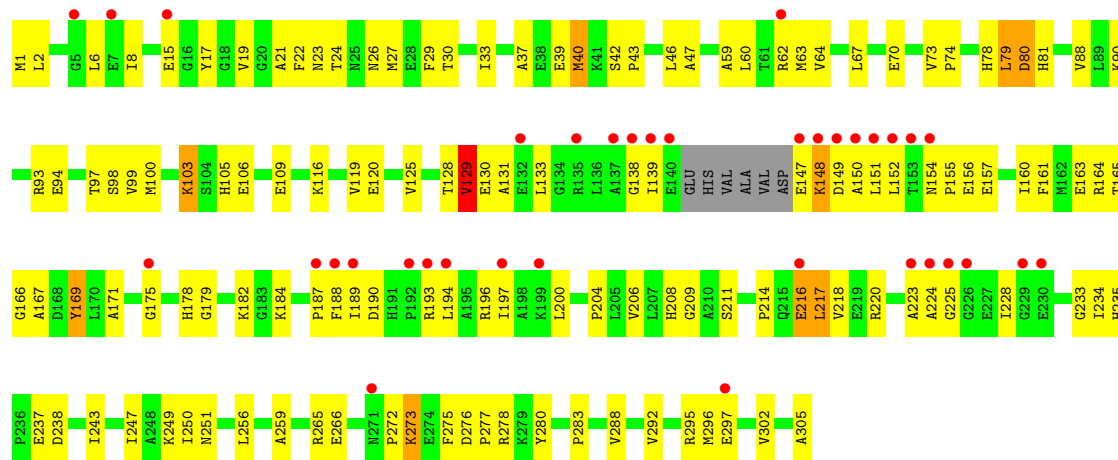


• Molecule 1: Fructose-bisphosphate aldolase

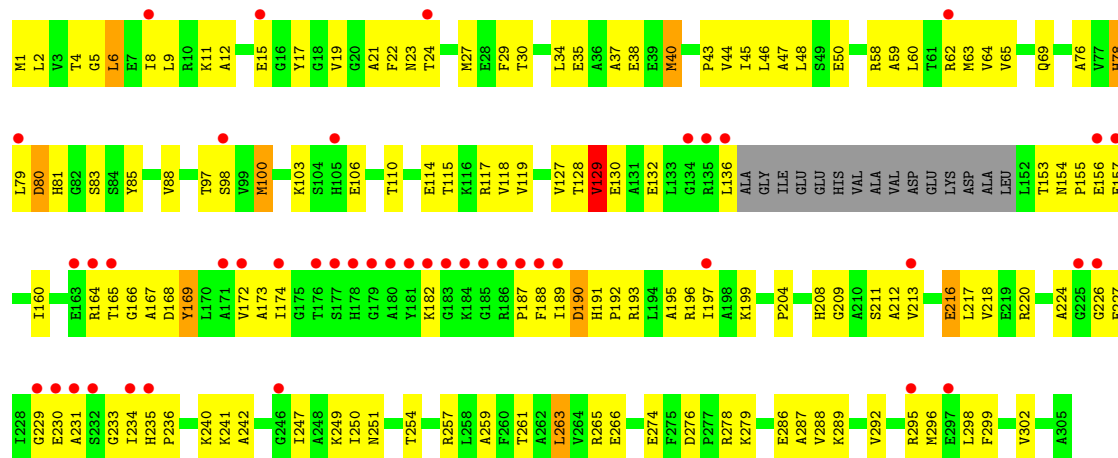


• Molecule 1: Fructose-bisphosphate aldolase





• Molecule 1: Fructose-bisphosphate aldolase



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	98.90Å 113.10Å 115.70Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 2.20 20.00 – 2.20	Depositor EDS
% Data completeness (in resolution range)	(Not available) (20.00-2.20) 94.4 (20.00-2.20)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.33 (at 2.16Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.237 , 0.286 0.250 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	26.0	Xtriage
Anisotropy	0.169	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.36 , 39.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.015 for -h,l,k	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	9340	wwPDB-VP
Average B, all atoms (Å ²)	30.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.04% 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, 0.333 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: 13P

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	0.42	0/2349	0.97	5/3156 (0.2%)
1	B	0.47	0/2292	1.06	8/3076 (0.3%)
1	C	0.45	0/2301	1.00	8/3088 (0.3%)
1	D	0.40	0/2236	0.96	6/3001 (0.2%)
All	All	0.44	0/9178	1.00	27/12321 (0.2%)

There are no bond length outliers.

The worst 5 of 27 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	79	LEU	N-CA-C	-18.44	81.00	110.32
1	B	80	ASP	N-CA-CB	-17.71	81.54	110.23
1	C	80	ASP	N-CA-CB	-14.65	85.34	110.83
1	B	79	LEU	CB-CA-C	-14.39	86.88	110.19
1	C	79	LEU	N-CA-C	-12.91	89.80	110.32

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	2320	0	2368	170	0
1	B	2265	0	2321	131	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	2274	0	2327	156	0
1	D	2209	0	2263	142	0
2	A	10	0	5	11	0
2	B	10	0	5	1	0
2	C	10	0	5	10	0
2	D	10	0	5	5	0
3	A	47	0	0	2	0
3	B	91	0	0	1	0
3	C	67	0	0	3	0
3	D	27	0	0	2	0
All	All	9340	0	9299	556	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 30.

The worst 5 of 556 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:B:61:THR:HG21	1:B:94:GLU:OE1	1.43	1.18
1:B:293:LYS:HA	1:B:296:MSE:HE2	1.19	1.17
1:A:208:HIS:HD2	2:A:1063:13P:O3	1.28	1.15
1:A:94:GLU:OE1	1:A:94:GLU:HA	1.42	1.09
1:B:109:GLU:OE2	1:B:164:ARG:NH2	1.85	1.08

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	303/305 (99%)	283 (93%)	16 (5%)	4 (1%)	9 8
1	B	294/305 (96%)	283 (96%)	10 (3%)	1 (0%)	36 42

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	C	295/305 (97%)	281 (95%)	12 (4%)	2 (1%)	18	19
1	D	286/305 (94%)	269 (94%)	14 (5%)	3 (1%)	12	11
All	All	1178/1220 (97%)	1116 (95%)	52 (4%)	10 (1%)	16	16

5 of 10 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	166	GLY
1	A	170	LEU
1	B	7	GLU
1	C	148	LYS
1	C	166	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	
1	A	237/229 (104%)	229 (97%)	8 (3%)	32	44
1	B	231/229 (101%)	218 (94%)	13 (6%)	19	24
1	C	232/229 (101%)	225 (97%)	7 (3%)	36	49
1	D	226/229 (99%)	217 (96%)	9 (4%)	28	38
All	All	926/916 (101%)	889 (96%)	37 (4%)	28	38

5 of 37 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	6	LEU
1	D	263	LEU
1	D	40	MSE
1	D	169	TYR
1	B	54	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 20 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	251	ASN
1	D	191	HIS
1	D	251	ASN
1	D	235	HIS
1	A	235	HIS

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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

4 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$
2	13P	B	1073	-	9,9,9	1.19	1 (11%)	10,12,12	1.23	1 (10%)
2	13P	A	1063	-	9,9,9	1.28	1 (11%)	10,12,12	1.15	1 (10%)
2	13P	C	1083	-	9,9,9	1.22	1 (11%)	10,12,12	1.33	1 (10%)
2	13P	D	1093	-	9,9,9	1.28	1 (11%)	10,12,12	1.27	1 (10%)

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
2	13P	B	1073	-	-	5/8/8/8	-
2	13P	A	1063	-	-	5/8/8/8	-
2	13P	C	1083	-	-	4/8/8/8	-
2	13P	D	1093	-	-	2/8/8/8	-

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1063	13P	P-O1P	3.34	1.60	1.50
2	D	1093	13P	P-O1P	3.01	1.59	1.50
2	C	1083	13P	P-O1P	2.94	1.59	1.50
2	B	1073	13P	P-O1P	2.85	1.59	1.50

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	1083	13P	O2P-P-O1	2.65	113.57	106.67
2	D	1093	13P	O2P-P-O1	2.49	113.15	106.67
2	B	1073	13P	O2P-P-O1	2.32	112.71	106.67
2	A	1063	13P	O2P-P-O1	2.17	112.33	106.67

There are no chirality outliers.

5 of 16 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	1063	13P	C1-O1-P-O2P
2	A	1063	13P	C1-O1-P-O3P
2	A	1063	13P	O1-C1-C2-C3
2	B	1073	13P	C1-O1-P-O1P
2	B	1073	13P	C1-O1-P-O2P

There are no ring outliers.

4 monomers are involved in 27 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	1073	13P	1	0
2	A	1063	13P	11	0
2	C	1083	13P	10	0
2	D	1093	13P	5	0

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	297/305 (97%)	0.70	35 (11%) 9 7	14, 29, 49, 82	0
1	B	290/305 (95%)	0.22	20 (6%) 23 20	11, 21, 36, 87	0
1	C	291/305 (95%)	0.75	36 (12%) 8 6	11, 27, 54, 82	0
1	D	282/305 (92%)	1.03	45 (15%) 5 3	15, 33, 67, 90	0
All	All	1160/1220 (95%)	0.67	136 (11%) 9 7	11, 27, 56, 90	0

The worst 5 of 136 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	178	HIS	6.8
1	B	149	ASP	6.7
1	A	149	ASP	6.3
1	D	179	GLY	5.8
1	D	180	ALA	5.6

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 oligosaccharides 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, 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	B-factors($\text{\AA}^2$)	Q<0.9
2	13P	D	1093	10/10	0.67	0.28	70,72,76,77	10
2	13P	A	1063	10/10	0.86	0.21	19,24,34,34	10
2	13P	C	1083	10/10	0.89	0.19	20,24,38,39	10
2	13P	B	1073	10/10	0.94	0.13	10,18,25,27	10

6.5 Other polymers [i](#)

There are no such residues in this entry.