



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 14, 2026 – 05:55 PM UTC

PDB ID : 2B24 / pdb_00002b24
Title : Crystal structure of naphthalene 1,2-dioxygenase from *Rhodococcus* sp. bound to indole
Authors : Gakhar, L.; Malik, Z.A.; Allen, C.C.; Lipscomb, D.A.; Larkin, M.J.; Ramaswamy, S.
Deposited on : 2005-09-16
Resolution : 3.00 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

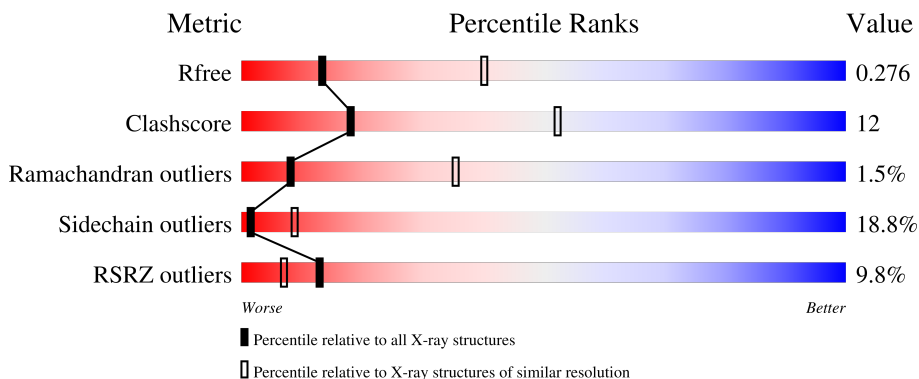
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.00 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}	180053	2672 (3.00-3.00)
Clashscore	190562	2977 (3.00-3.00)
Ramachandran outliers	187476	2877 (3.00-3.00)
Sidechain outliers	187428	2880 (3.00-3.00)
RSRZ outliers	180081	2671 (3.00-3.00)

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	470	
1	C	470	
1	E	470	
2	B	172	
2	D	172	

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Mol	Chain	Length	Quality of chain
2	F	172	

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
4	FES	A	501	-	-	X	-
5	IND	A	503	-	X	-	-
5	IND	C	503	-	X	-	-

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 14862 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 naphthalene dioxygenase large subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	440	3506	2232	605	649	20	0	0	0
1	C	440	3506	2232	605	649	20	0	0	0
1	E	440	3506	2232	605	649	20	0	0	0

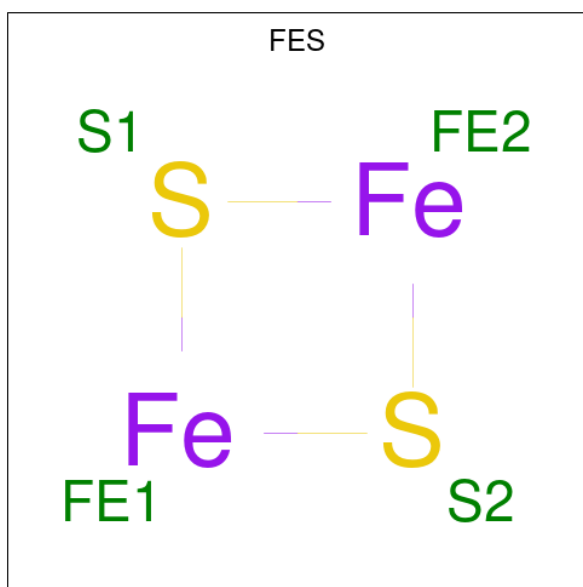
- Molecule 2 is a protein called naphthalene dioxygenase small subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	165	1330	827	229	266	8	0	0	0
2	D	165	1330	827	229	266	8	0	0	0
2	F	165	1330	827	229	266	8	0	0	0

- Molecule 3 is FE (III) ION (CCD ID: FE) (formula: Fe).

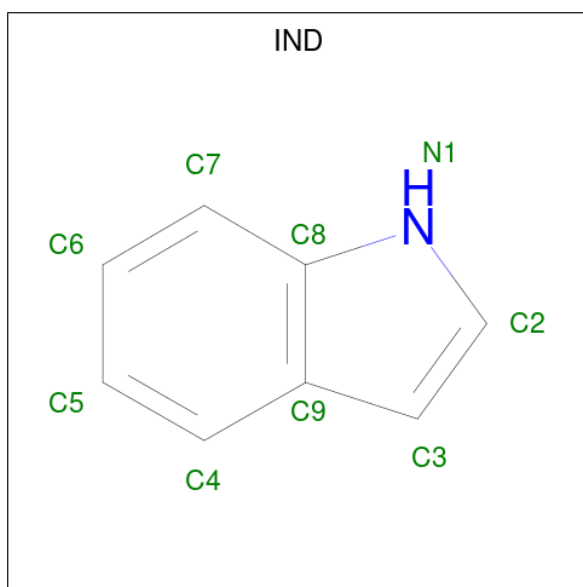
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Fe	0	0
			1	1		
3	C	1	Total	Fe	0	0
			1	1		
3	E	1	Total	Fe	0	0
			1	1		

- Molecule 4 is FE2/S2 (INORGANIC) CLUSTER (CCD ID: FES) (formula: Fe₂S₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	Fe	S	0	0
			4	2	2		
4	C	1	Total	Fe	S	0	0
			4	2	2		
4	E	1	Total	Fe	S	0	0
			4	2	2		

- Molecule 5 is INDOLE (CCD ID: IND) (formula: C₈H₇N).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	N	0	0
			9	8	1		

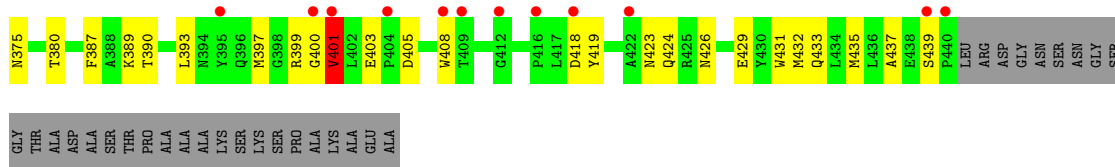
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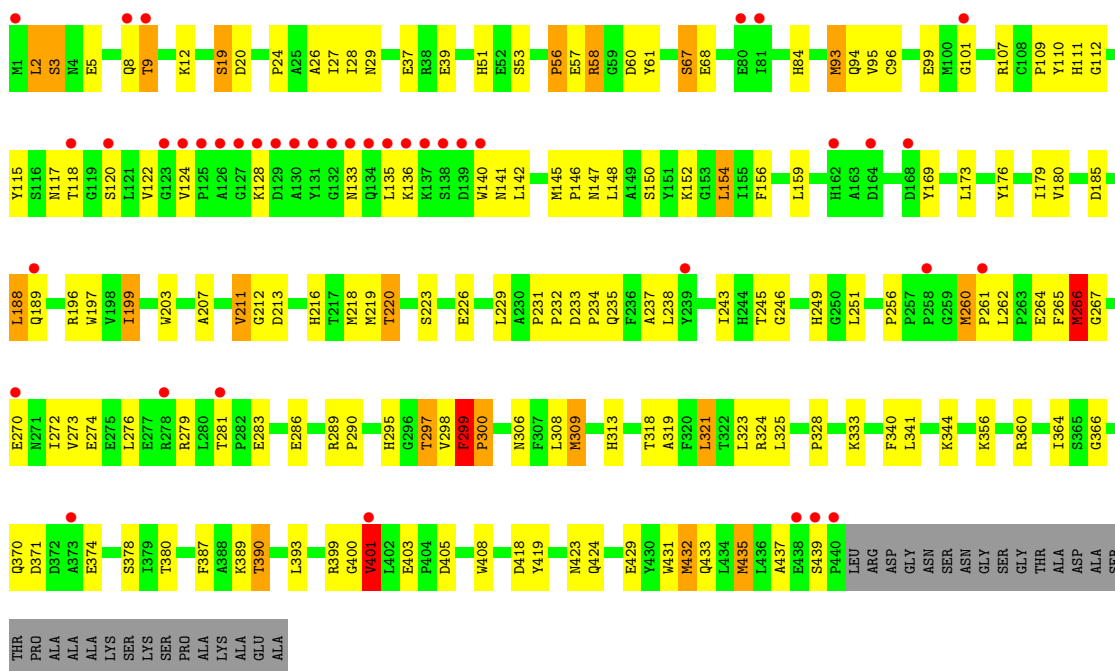
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	C	1	Total	C	N	0	0
			9	8	1		
5	E	1	Total	C	N	0	0
			9	8	1		

- Molecule 6 is water.

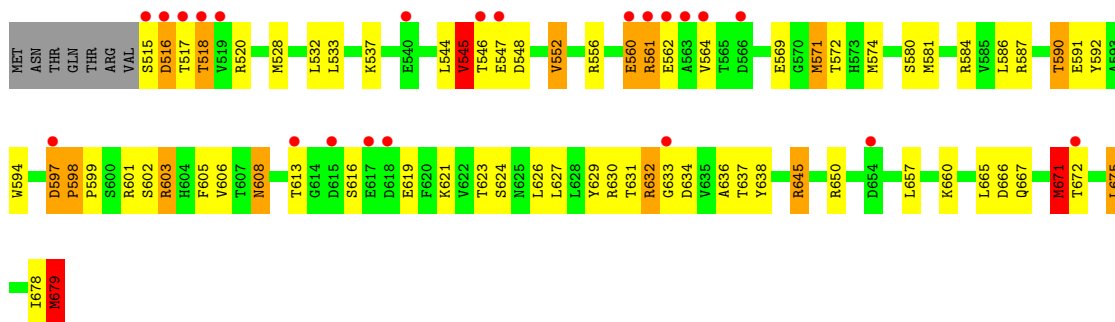
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	66	Total	O	0	0
			66	66		
6	B	35	Total	O	0	0
			35	35		
6	C	64	Total	O	0	0
			64	64		
6	D	29	Total	O	0	0
			29	29		
6	E	82	Total	O	0	0
			82	82		
6	F	36	Total	O	0	0
			36	36		



• Molecule 1: naphthalene dioxygenase large subunit

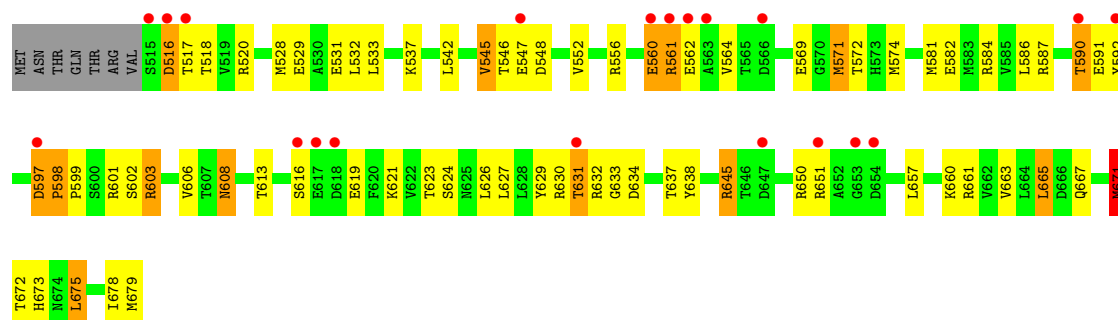


• Molecule 2: naphthalene dioxygenase small subunit

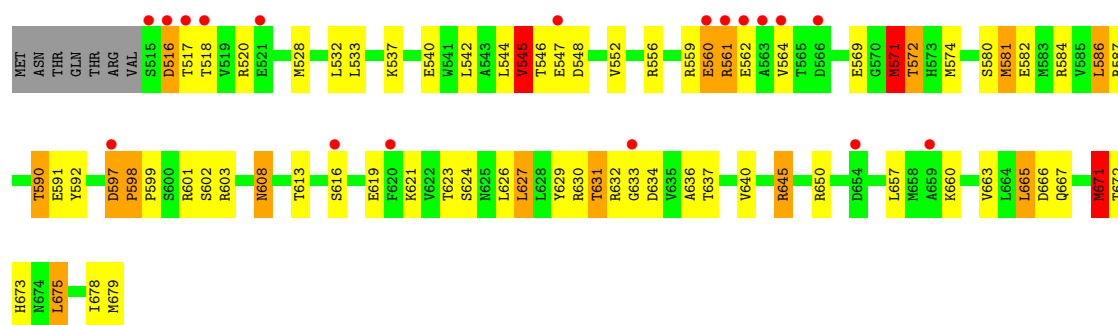


• Molecule 2: naphthalene dioxygenase small subunit





- Molecule 2: naphthalene dioxygenase small subunit



4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, α , β , γ	179.36Å 179.36Å 245.41Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.42 – 3.00 20.42 – 3.00	Depositor EDS
% Data completeness (in resolution range)	99.3 (20.42-3.00) 98.9 (20.42-3.00)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	4.37 (at 2.98Å)	Xtrriage
Refinement program	REFMAC 5.1.27	Depositor
R, R_{free}	0.287 , 0.300 0.265 , 0.276	Depositor DCC
R_{free} test set	2441 reflections (3.03%)	wwPDB-VP
Wilson B-factor (Å ²)	49.0	Xtrriage
Anisotropy	0.106	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 45.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.37$, $\langle L^2 \rangle = 0.20$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.86	EDS
Total number of atoms	14862	wwPDB-VP
Average B, all atoms (Å ²)	91.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.31% 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: FES, IND, FE

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	0.66	2/3612 (0.1%)	0.97	2/4908 (0.0%)
1	C	0.77	4/3612 (0.1%)	1.13	7/4908 (0.1%)
1	E	0.74	5/3612 (0.1%)	0.95	1/4908 (0.0%)
2	B	0.86	3/1350 (0.2%)	1.03	2/1831 (0.1%)
2	D	0.72	1/1350 (0.1%)	1.03	1/1831 (0.1%)
2	F	0.90	3/1350 (0.2%)	1.06	2/1831 (0.1%)
All	All	0.75	18/14886 (0.1%)	1.02	15/20217 (0.1%)

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	A	0	1
1	C	0	4
1	E	0	1
2	B	0	1
2	D	0	1
2	F	0	1
All	All	0	9

The worst 5 of 18 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	2	LEU	C-N	-22.95	1.01	1.33
1	C	2	LEU	N-CA	12.85	1.61	1.46
2	F	671	MET	SD-CE	-12.27	1.48	1.79
1	C	2	LEU	CB-CG	10.48	1.74	1.53
2	B	671	MET	SD-CE	-10.44	1.53	1.79

The worst 5 of 15 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	1	MET	O-C-N	-30.39	74.38	123.00
1	C	2	LEU	O-C-N	-21.01	96.42	122.26
1	A	2	LEU	N-CA-C	-15.76	84.79	110.17
1	C	2	LEU	CA-C-N	15.50	151.15	121.54
1	C	2	LEU	C-N-CA	15.50	151.15	121.54

There are no chirality outliers.

5 of 9 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	299	PHE	Peptide
2	B	597	ASP	Peptide
1	C	1	MET	Mainchain
1	C	2	LEU	Mainchain,Peptide
1	C	299	PHE	Peptide

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	3506	0	3333	81	0
1	C	3506	0	3332	90	0
1	E	3506	0	3333	96	0
2	B	1330	0	1303	41	0
2	D	1330	0	1303	36	0
2	F	1330	0	1303	42	0
3	A	1	0	0	0	0
3	C	1	0	0	0	0
3	E	1	0	0	0	0
4	A	4	0	0	3	0
4	C	4	0	0	1	0
4	E	4	0	0	1	0
5	A	9	0	7	0	0
5	C	9	0	7	0	0
5	E	9	0	7	0	0
6	A	66	0	0	2	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	B	35	0	0	2	0
6	C	64	0	0	2	0
6	D	29	0	0	1	0
6	E	82	0	0	5	0
6	F	36	0	0	1	0
All	All	14862	0	13928	347	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 12.

The worst 5 of 347 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:5:GLU:O	1:C:9:THR:HG22	1.85	0.77
1:A:112:GLY:HA2	1:C:219:MET:HG2	1.68	0.75
1:E:286:GLU:OE2	1:E:289:ARG:NH1	2.20	0.75
1:A:5:GLU:O	1:A:9:THR:HG22	1.86	0.74
1:E:5:GLU:O	1:E:9:THR:HG22	1.87	0.74

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	438/470 (93%)	395 (90%)	35 (8%)	8 (2%)	6	31
1	C	438/470 (93%)	393 (90%)	39 (9%)	6 (1%)	9	36
1	E	438/470 (93%)	392 (90%)	39 (9%)	7 (2%)	7	34
2	B	163/172 (95%)	147 (90%)	14 (9%)	2 (1%)	10	40
2	D	163/172 (95%)	149 (91%)	12 (7%)	2 (1%)	10	40

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	F	163/172 (95%)	147 (90%)	14 (9%)	2 (1%)	10	40
All	All	1803/1926 (94%)	1623 (90%)	153 (8%)	27 (2%)	8	35

5 of 27 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	299	PHE
2	B	516	ASP
2	B	545	VAL
1	C	3	SER
1	C	299	PHE

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	370/389 (95%)	314 (85%)	56 (15%)	3	14
1	C	370/389 (95%)	311 (84%)	59 (16%)	2	13
1	E	370/389 (95%)	314 (85%)	56 (15%)	3	14
2	B	147/154 (96%)	106 (72%)	41 (28%)	0	2
2	D	147/154 (96%)	107 (73%)	40 (27%)	0	2
2	F	147/154 (96%)	108 (74%)	39 (26%)	0	3
All	All	1551/1629 (95%)	1260 (81%)	291 (19%)	1	9

5 of 291 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	272	ILE
2	F	665	LEU
1	E	309	MET
2	F	552	VAL
1	C	2	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 34 such sidechains are listed below:

Mol	Chain	Res	Type
1	E	249	HIS
1	E	271	ASN
1	E	433	GLN
1	C	15	HIS
2	B	608	ASN

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](#)

Of 9 ligands modelled in this entry, 3 are monoatomic - leaving 6 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	$\# Z > 2$
4	FES	A	501	1	0,4,4	-	-	-		
5	IND	C	503	-	10,10,10	2.17	5 (50%)	13,13,13	2.15	6 (46%)
5	IND	E	503	-	10,10,10	2.04	4 (40%)	13,13,13	1.69	3 (23%)
4	FES	E	501	1	0,4,4	-	-	-		
4	FES	C	501	1	0,4,4	-	-	-		
5	IND	A	503	-	10,10,10	1.81	4 (40%)	13,13,13	2.39	6 (46%)

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
4	FES	A	501	1	-	-	0/1/1/1
5	IND	C	503	-	-	-	0/2/2/2
5	IND	E	503	-	-	-	0/2/2/2
4	FES	E	501	1	-	-	0/1/1/1
4	FES	C	501	1	-	-	0/1/1/1
5	IND	A	503	-	-	-	0/2/2/2

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	C	503	IND	C7-C8	3.64	1.45	1.39
5	E	503	IND	C7-C8	3.41	1.45	1.39
5	C	503	IND	C2-C3	3.04	1.41	1.36
5	A	503	IND	C2-C3	2.92	1.41	1.36
5	E	503	IND	C2-C3	2.75	1.41	1.36

The worst 5 of 15 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	503	IND	C8-N1-C2	-4.88	105.35	108.91
5	C	503	IND	C8-N1-C2	-4.58	105.57	108.91
5	A	503	IND	C9-C8-N1	3.27	110.16	107.53
5	C	503	IND	C7-C8-C9	-3.19	119.24	122.13
5	E	503	IND	C8-C9-C3	3.17	108.59	106.59

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

3 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	501	FES	3	0
4	E	501	FES	1	0
4	C	501	FES	1	0

5.7 Other polymers [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues [i](#)

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	C	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	C	2:LEU	C	3:SER	N	1.01

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	440/470 (93%)	0.78	37 (8%) 17 9	76, 92, 108, 140	0
1	C	440/470 (93%)	0.93	39 (8%) 15 8	76, 92, 108, 140	0
1	E	440/470 (93%)	0.98	41 (9%) 14 7	76, 92, 108, 140	0
2	B	165/172 (95%)	0.88	22 (13%) 7 4	75, 89, 111, 126	0
2	D	165/172 (95%)	0.81	20 (12%) 8 5	75, 89, 111, 126	0
2	F	165/172 (95%)	0.94	18 (10%) 10 6	75, 89, 111, 126	0
All	All	1815/1926 (94%)	0.89	177 (9%) 13 7	75, 91, 110, 140	0

The worst 5 of 177 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	137	LYS	9.7
1	E	133	ASN	9.5
1	E	135	LEU	9.1
1	C	440	PRO	8.6
1	E	132	GLY	7.9

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(Å ²)	Q<0.9
5	IND	C	503	9/9	0.88	0.28	71,72,73,73	0
5	IND	E	503	9/9	0.88	0.19	71,72,73,73	0
5	IND	A	503	9/9	0.93	0.22	71,72,73,73	0
3	FE	C	502	1/1	0.96	0.07	69,69,69,69	0
3	FE	E	502	1/1	0.97	0.07	66,66,66,66	0
4	FES	A	501	4/4	0.98	0.11	60,60,60,64	0
3	FE	A	502	1/1	0.98	0.07	66,66,66,66	0
4	FES	E	501	4/4	0.99	0.05	58,59,60,62	0
4	FES	C	501	4/4	0.99	0.06	58,59,59,62	0

6.5 Other polymers [i](#)

There are no such residues in this entry.