



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 17, 2026 – 09:30 PM UTC

PDB ID : 5AIU / pdb_00005aiu
Title : A complex of RNF4-RING domain, Ubc13-Ub (isopeptide crosslink)
Authors : Branigan, E.; Naismith, J.H.
Deposited on : 2015-02-17
Resolution : 2.21 Å(reported)

This is a Full wwPDB X-ray Structure Validation 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

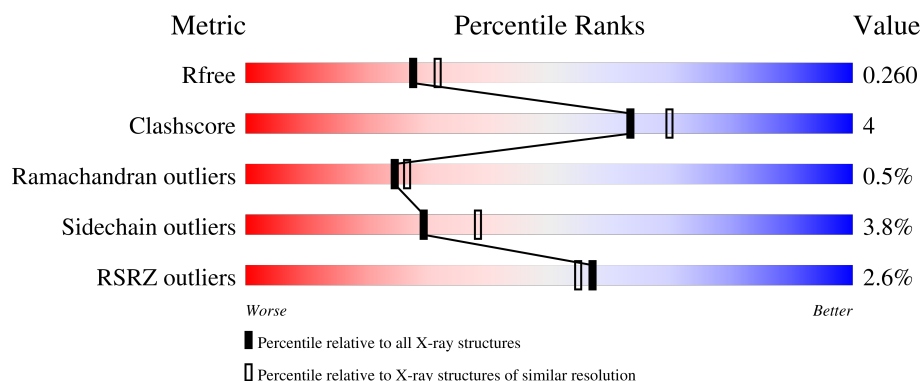
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

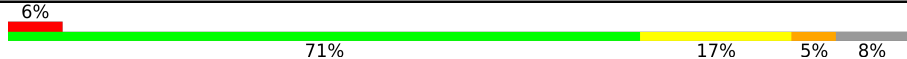
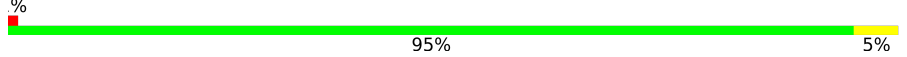
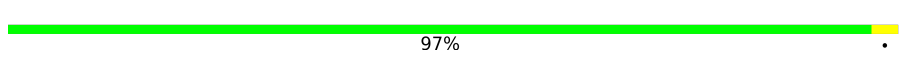
The reported resolution of this entry is 2.21 Å.

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	7682 (2.24-2.20)
Clashscore	190562	8402 (2.24-2.20)
Ramachandran outliers	187476	8303 (2.24-2.20)
Sidechain outliers	187428	8304 (2.24-2.20)
RSRZ outliers	180081	7683 (2.24-2.20)

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	133	
2	B	154	
2	E	154	
3	C	76	
3	F	76	

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	1152	-	-	X	-
5	EDO	E	1152	-	-	X	-

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 4591 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 E3 UBIQUITIN-PROTEIN LIGASE RNF4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	123	Total	C	N	O	S	0	1	0
			948	584	170	178	16			

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	127	GLY	-	expression tag	UNP O88846
A	128	ALA	-	expression tag	UNP O88846
A	129	MET	-	expression tag	UNP O88846
A	130	GLY	-	expression tag	UNP O88846
A	195	GLY	-	linker	UNP O88846

- Molecule 2 is a protein called UBIQUITIN-CONJUGATING ENZYME E2 N.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	150	Total	C	N	O	S	0	0	0
			1190	764	206	217	3			
2	E	150	Total	C	N	O	S	0	0	0
			1190	764	206	217	3			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-1	GLY	-	expression tag	UNP P61088
B	0	ALA	-	expression tag	UNP P61088
B	87	LYS	CYS	engineered mutation	UNP P61088
B	92	ALA	LYS	engineered mutation	UNP P61088
E	-1	GLY	-	expression tag	UNP P61088
E	0	ALA	-	expression tag	UNP P61088
E	87	LYS	CYS	engineered mutation	UNP P61088
E	92	ALA	LYS	engineered mutation	UNP P61088

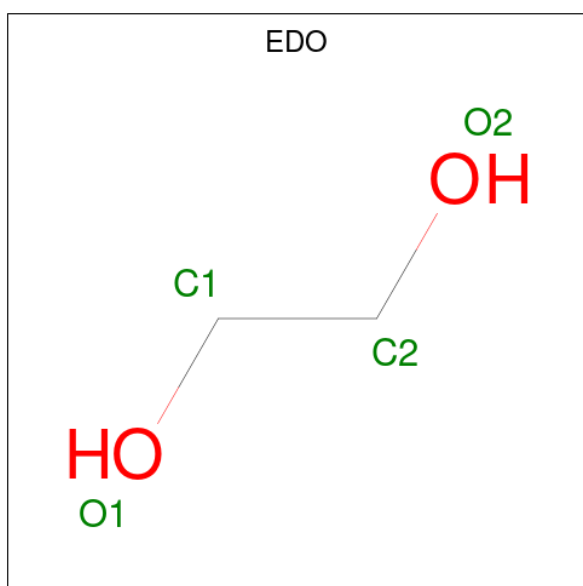
- Molecule 3 is a protein called POLYUBIQUITIN-C.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	76	Total	C	N	O	S	0	0	0
			601	378	105	117	1			
3	F	76	Total	C	N	O	S	0	0	0
			601	378	105	117	1			

- Molecule 4 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	4	Total	Zn	0	0
			4	4		

- Molecule 5 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: C₂H₆O₂).



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

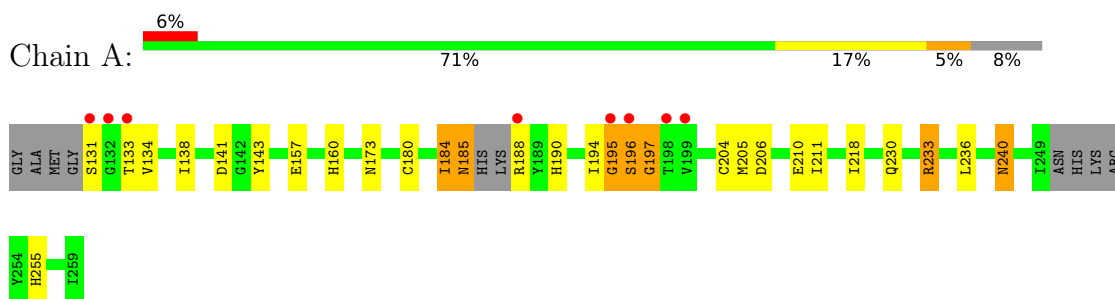
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	6	Total 6	O 6	0	0
6	B	10	Total 10	O 10	0	0
6	C	2	Total 2	O 2	0	0
6	E	12	Total 12	O 12	0	0
6	F	3	Total 3	O 3	0	0

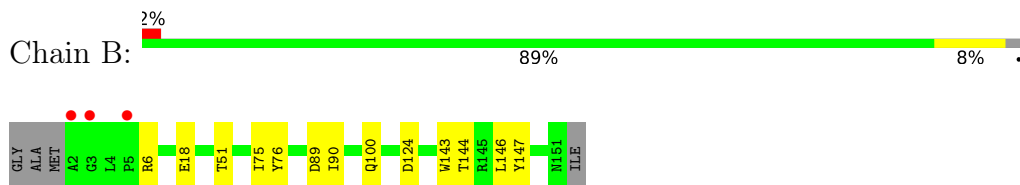
3 Residue-property plots

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.

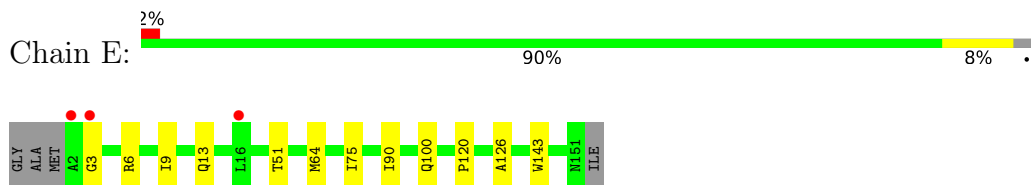
- Molecule 1: E3 UBIQUITIN-PROTEIN LIGASE RNF4



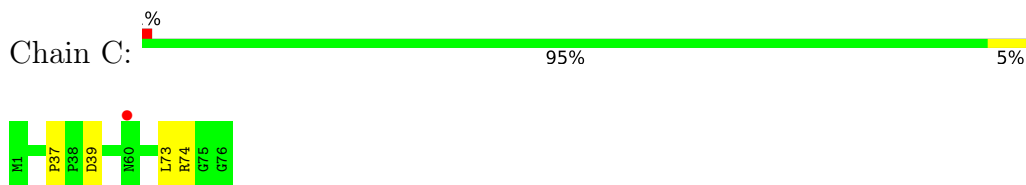
- Molecule 2: UBIQUITIN-CONJUGATING ENZYME E2 N



- Molecule 2: UBIQUITIN-CONJUGATING ENZYME E2 N



- Molecule 3: POLYUBIQUITIN-C



- Molecule 3: POLYUBIQUITIN-C





4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α , β , γ	69.19Å 169.21Å 52.62Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	32.02 – 2.21 32.02 – 2.21	Depositor EDS
% Data completeness (in resolution range)	94.9 (32.02-2.21) 95.4 (32.02-2.21)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	7.58 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.8.0073	Depositor
R, R_{free}	0.217 , 0.255 0.225 , 0.260	Depositor DCC
R_{free} test set	1536 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	22.2	Xtriage
Anisotropy	0.146	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.37 , 31.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.39$, $\langle L^2 \rangle = 0.21$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	4591	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 4.89% 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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: ZN, 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	A	0.97	0/966	1.14	4/1301 (0.3%)
2	B	0.97	0/1220	0.99	0/1662
2	E	0.95	0/1220	1.03	1/1662 (0.1%)
3	C	0.94	1/607 (0.2%)	1.03	0/816
3	F	0.91	0/607	0.98	0/816
All	All	0.95	1/4620 (0.0%)	1.04	5/6257 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	37	PRO	CA-C	5.24	1.55	1.52

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	E	3	GLY	N-CA-C	8.21	123.10	111.19
1	A	190	HIS	N-CA-C	7.60	117.07	108.25
1	A	184	ILE	N-CA-C	5.86	114.79	106.53
1	A	173	ASN	N-CA-C	5.69	118.69	111.69
1	A	255	HIS	N-CA-C	5.58	113.15	108.13

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	948	0	927	15	0
2	B	1190	0	1200	13	0
2	E	1190	0	1200	11	0
3	C	601	0	629	1	0
3	F	601	0	629	0	0
4	A	4	0	0	0	0
5	A	4	0	6	0	0
5	B	8	0	12	11	0
5	C	4	0	6	0	0
5	E	4	0	6	7	0
5	F	4	0	6	0	0
6	A	6	0	0	0	0
6	B	10	0	0	0	0
6	C	2	0	0	0	0
6	E	12	0	0	0	0
6	F	3	0	0	0	0
All	All	4591	0	4621	37	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.

All (37) 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)
2:B:75:ILE:HA	5:B:1152:EDO:H11	1.39	1.02
2:B:144:THR:N	5:B:1152:EDO:H21	1.91	0.85
2:E:75:ILE:HA	5:E:1152:EDO:H21	1.61	0.82
2:B:143:TRP:C	5:B:1152:EDO:H21	2.04	0.82
2:E:75:ILE:HG13	5:E:1152:EDO:H12	1.70	0.74
1:A:236:LEU:HD23	1:A:240:ASN:HA	1.71	0.73
2:B:75:ILE:HA	5:B:1152:EDO:C1	2.17	0.73
2:E:143:TRP:HB3	5:E:1152:EDO:H22	1.70	0.73
2:E:143:TRP:C	5:E:1152:EDO:H22	2.18	0.69
1:A:157:GLU:OE2	1:A:188:ARG:NH1	2.24	0.67
2:B:75:ILE:CA	5:B:1152:EDO:H11	2.21	0.66
1:A:196:SER:OG	1:A:197:GLY:N	2.34	0.61
2:B:144:THR:CA	5:B:1152:EDO:H21	2.30	0.61
2:B:143:TRP:HB3	5:B:1152:EDO:H12	1.81	0.61
2:B:144:THR:HA	5:B:1152:EDO:C2	2.34	0.57
2:E:75:ILE:HA	5:E:1152:EDO:C2	2.34	0.57

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:134:VAL:HG21	1:A:194:ILE:HD12	1.86	0.56
2:B:144:THR:HA	5:B:1152:EDO:H21	1.89	0.54
2:B:76:TYR:H	5:B:1152:EDO:C1	2.21	0.54
1:A:138:ILE:HG21	2:E:64:MET:HE1	1.90	0.53
2:E:143:TRP:CB	5:E:1152:EDO:H22	2.38	0.53
1:A:141:ASP:OD1	2:E:6:ARG:HD2	2.08	0.52
1:A:230[B]:GLN:OE1	1:A:233:ARG:NH1	2.42	0.49
1:A:185:ASN:N	1:A:185:ASN:OD1	2.45	0.49
1:A:194:ILE:O	1:A:195:GLY:C	2.55	0.49
1:A:195:GLY:O	1:A:196:SER:C	2.58	0.47
2:E:9:ILE:HG22	2:E:13:GLN:OE1	2.15	0.46
1:A:204:CYS:O	1:A:205:MET:HB2	2.18	0.44
2:B:89:ASP:OD2	3:C:74:ARG:HB3	2.17	0.44
1:A:160:HIS:CE1	1:A:180:CYS:HB3	2.54	0.43
2:B:146:LEU:HD23	2:B:147:TYR:CE2	2.54	0.43
1:A:211:ILE:HG21	1:A:218:ILE:HD13	2.00	0.42
1:A:206:ASP:HB3	1:A:210:GLU:HB2	2.02	0.41
2:B:143:TRP:CB	5:B:1152:EDO:H12	2.47	0.41
2:E:143:TRP:HB3	5:E:1152:EDO:C2	2.46	0.41
1:A:143:TYR:CZ	1:A:195:GLY:HA2	2.56	0.40
2:E:120:PRO:HB3	2:E:126:ALA:HB2	2.03	0.40

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	118/133 (89%)	110 (93%)	5 (4%)	3 (2%)	4	2
2	B	148/154 (96%)	143 (97%)	5 (3%)	0	100	100
2	E	148/154 (96%)	143 (97%)	5 (3%)	0	100	100
3	C	74/76 (97%)	74 (100%)	0	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
3	F	74/76 (97%)	74 (100%)	0	0	100	100
All	All	562/593 (95%)	544 (97%)	15 (3%)	3 (0%)	24	26

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	196	SER
1	A	195	GLY
1	A	197	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	113/119 (95%)	107 (95%)	6 (5%)	20	24
2	B	126/128 (98%)	120 (95%)	6 (5%)	23	28
2	E	126/128 (98%)	123 (98%)	3 (2%)	43	56
3	C	68/68 (100%)	66 (97%)	2 (3%)	37	49
3	F	68/68 (100%)	66 (97%)	2 (3%)	37	49
All	All	501/511 (98%)	482 (96%)	19 (4%)	29	38

All (19) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	131	SER
1	A	133	THR
1	A	184	ILE
1	A	185	ASN
1	A	233	ARG
1	A	240	ASN
2	B	6	ARG
2	B	18	GLU
2	B	51	THR

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Mol	Chain	Res	Type
2	B	90	ILE
2	B	100	GLN
2	B	124	ASP
3	C	39	ASP
3	C	73	LEU
2	E	51	THR
2	E	90	ILE
2	E	100	GLN
3	F	39	ASP
3	F	73	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	109	GLN
2	E	109	GLN
2	E	123	ASN
3	F	49	GLN

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 oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 10 ligands modelled in this entry, 4 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	$\# Z > 2$
5	EDO	B	1152	-	3,3,3	0.18	0	2,2,2	0.19	0
5	EDO	A	1260	-	3,3,3	0.76	0	2,2,2	0.68	0
5	EDO	F	1077	-	3,3,3	0.36	0	2,2,2	0.68	0
5	EDO	C	1077	-	3,3,3	0.70	0	2,2,2	0.55	0
5	EDO	B	1153	-	3,3,3	0.41	0	2,2,2	0.23	0
5	EDO	E	1152	-	3,3,3	0.44	0	2,2,2	0.20	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	B	1152	-	-	0/1/1/1	-
5	EDO	A	1260	-	-	0/1/1/1	-
5	EDO	F	1077	-	-	0/1/1/1	-
5	EDO	C	1077	-	-	0/1/1/1	-
5	EDO	B	1153	-	-	1/1/1/1	-
5	EDO	E	1152	-	-	0/1/1/1	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	B	1153	EDO	O1-C1-C2-O2

There are no ring outliers.

2 monomers are involved in 18 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	B	1152	EDO	11	0
5	E	1152	EDO	7	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	123/133 (92%)	0.10	8 (6%)	25 22	11, 23, 47, 57	1 (0%)
2	B	150/154 (97%)	-0.03	3 (2%)	65 63	12, 20, 33, 74	0
2	E	150/154 (97%)	-0.02	3 (2%)	65 63	14, 22, 36, 62	0
3	C	76/76 (100%)	-0.12	1 (1%)	75 73	15, 23, 36, 41	0
3	F	76/76 (100%)	-0.20	0	100 100	15, 22, 35, 41	0
All	All	575/593 (96%)	-0.04	15 (2%)	57 55	11, 22, 39, 74	1 (0%)

All (15) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	2	ALA	7.4
2	E	2	ALA	4.8
2	B	3	GLY	3.9
1	A	131	SER	3.6
1	A	198	THR	2.8
1	A	133	THR	2.7
2	E	16	LEU	2.5
1	A	195	GLY	2.5
2	E	3	GLY	2.4
3	C	60	ASN	2.2
1	A	199	VAL	2.1
1	A	132	GLY	2.1
1	A	188	ARG	2.1
2	B	5	PRO	2.0
1	A	196	SER	2.0

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
5	EDO	E	1152	4/4	0.92	0.20	24,24,25,26	0
5	EDO	C	1077	4/4	0.93	0.07	15,15,16,16	0
5	EDO	F	1077	4/4	0.94	0.08	17,17,17,19	0
5	EDO	A	1260	4/4	0.95	0.06	14,14,15,16	0
5	EDO	B	1153	4/4	0.96	0.06	23,23,24,24	0
5	EDO	B	1152	4/4	0.96	0.17	19,21,21,21	0
4	ZN	A	800	1/1	0.99	0.01	18,18,18,18	0
4	ZN	A	803	1/1	0.99	0.02	17,17,17,17	0
4	ZN	A	802	1/1	1.00	0.01	17,17,17,17	0
4	ZN	A	801	1/1	1.00	0.02	16,16,16,16	0

6.5 Other polymers [i](#)

There are no such residues in this entry.