



# wwPDB X-ray Structure Validation Summary Report ⓘ

Aug 20, 2023 – 02:42 PM EDT

PDB ID : 2OKW  
Title : A non-invasive GFP-based biosensor for mercury ions  
Authors : Chapleau, R.R.; Blomberg, R.; Ford, P.C.; Sagermann, M.  
Deposited on : 2007-01-17  
Resolution : 1.90 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](mailto: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>.

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

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtrriage (Phenix) : 1.13  
EDS : 2.35  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.35

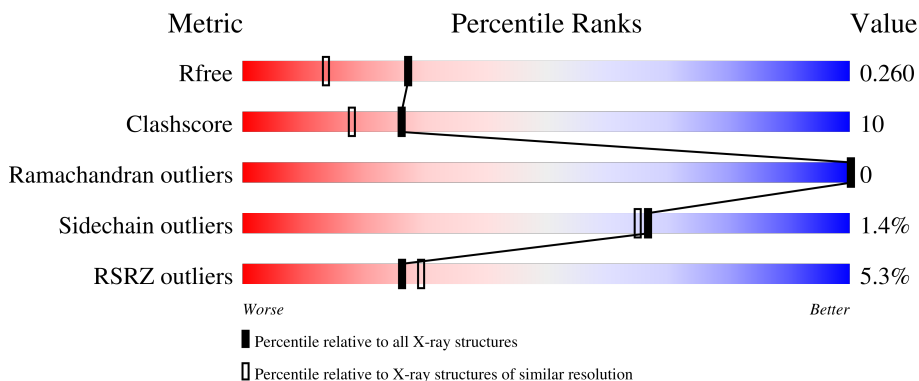
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.90 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.



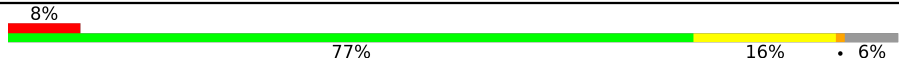
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	130704	6207 (1.90-1.90)
Clashscore	141614	6847 (1.90-1.90)
Ramachandran outliers	138981	6760 (1.90-1.90)
Sidechain outliers	138945	6760 (1.90-1.90)
RSRZ outliers	127900	6082 (1.90-1.90)

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  $\geq 3$ , 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	236	 3% 75% 17% • 6%
1	B	236	 4% 74% 19% • 6%
1	C	236	 5% 75% 17% • 6%
1	D	236	 4% 77% 17% 6%
1	E	236	 6% 72% 21% 6%

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Mol	Chain	Length	Quality of chain
1	F	236	

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
1	CRO	A	66	X	-	-	-
1	CRO	B	66	X	-	-	-
1	CRO	C	66	X	-	-	-
1	CRO	D	66	X	-	-	-
1	CRO	E	66	X	-	-	-
1	CRO	F	66	X	-	-	-

## 2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 11790 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 Green fluorescent protein.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	221	1772	1130	299	336	7	0	0	0
1	B	221	1772	1130	299	336	7	0	0	0
1	C	221	1772	1130	299	336	7	0	0	0
1	D	221	1772	1130	299	336	7	0	0	0
1	E	221	1772	1130	299	336	7	0	0	0
1	F	221	1772	1130	299	336	7	0	0	0

There are 30 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	64	LEU	PHE	SEE REMARK 999	UNP P42212
A	66	CRO	SER	chromophore	UNP P42212
A	66	CRO	TYR	chromophore	UNP P42212
A	66	CRO	GLY	chromophore	UNP P42212
A	205	CYS	SER	engineered mutation	UNP P42212
B	64	LEU	PHE	SEE REMARK 999	UNP P42212
B	66	CRO	SER	chromophore	UNP P42212
B	66	CRO	TYR	chromophore	UNP P42212
B	66	CRO	GLY	chromophore	UNP P42212
B	205	CYS	SER	engineered mutation	UNP P42212
C	64	LEU	PHE	SEE REMARK 999	UNP P42212
C	66	CRO	SER	chromophore	UNP P42212
C	66	CRO	TYR	chromophore	UNP P42212
C	66	CRO	GLY	chromophore	UNP P42212
C	205	CYS	SER	engineered mutation	UNP P42212
D	64	LEU	PHE	SEE REMARK 999	UNP P42212
D	66	CRO	SER	chromophore	UNP P42212

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Chain	Residue	Modelled	Actual	Comment	Reference
D	66	CRO	TYR	chromophore	UNP P42212
D	66	CRO	GLY	chromophore	UNP P42212
D	205	CYS	SER	engineered mutation	UNP P42212
E	64	LEU	PHE	SEE REMARK 999	UNP P42212
E	66	CRO	SER	chromophore	UNP P42212
E	66	CRO	TYR	chromophore	UNP P42212
E	66	CRO	GLY	chromophore	UNP P42212
E	205	CYS	SER	engineered mutation	UNP P42212
F	64	LEU	PHE	SEE REMARK 999	UNP P42212
F	66	CRO	SER	chromophore	UNP P42212
F	66	CRO	TYR	chromophore	UNP P42212
F	66	CRO	GLY	chromophore	UNP P42212
F	205	CYS	SER	engineered mutation	UNP P42212

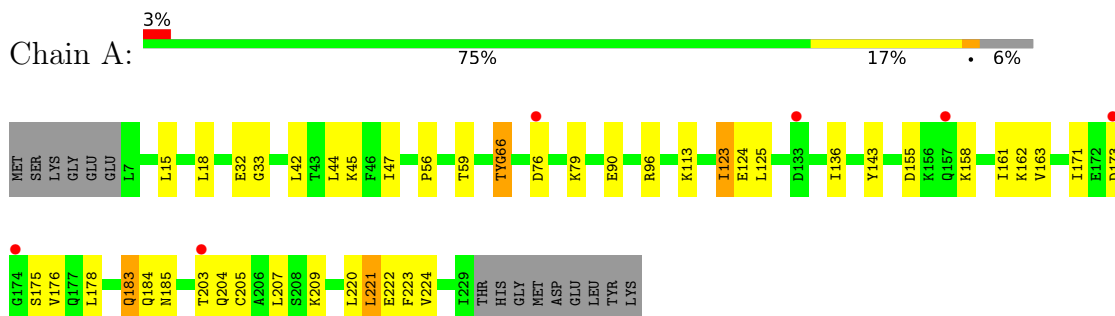
- Molecule 2 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	196	Total O 196 196	0	0
2	B	197	Total O 197 197	0	0
2	C	189	Total O 189 189	0	0
2	D	188	Total O 188 188	0	0
2	E	196	Total O 196 196	0	0
2	F	192	Total O 192 192	0	0

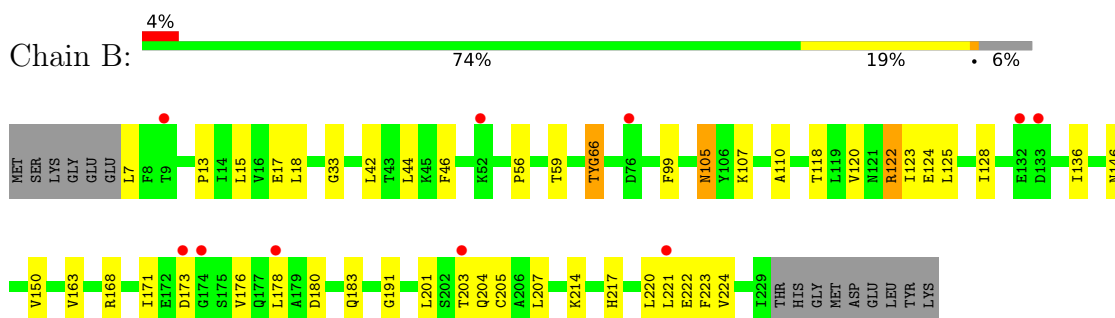
### 3 Residue-property plots [i](#)

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.

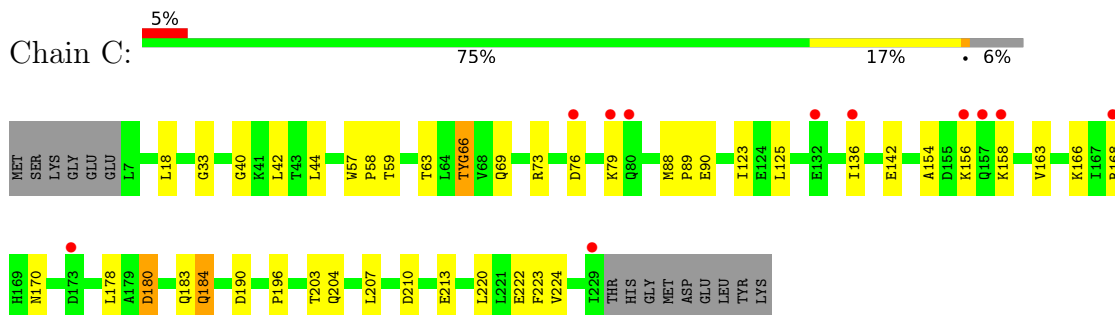
- Molecule 1: Green fluorescent protein



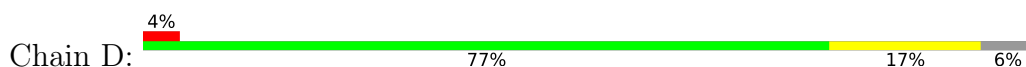
- Molecule 1: Green fluorescent protein

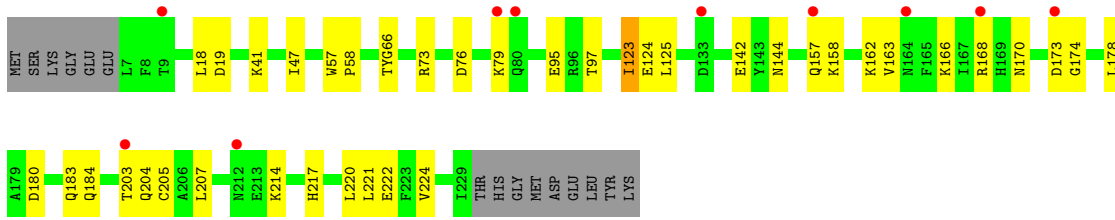


- Molecule 1: Green fluorescent protein

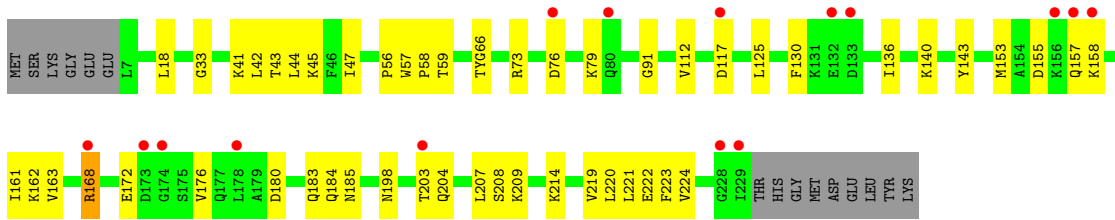
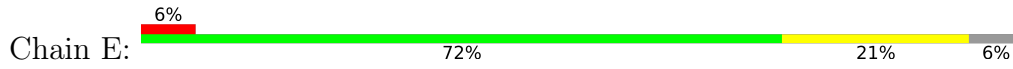


- Molecule 1: Green fluorescent protein

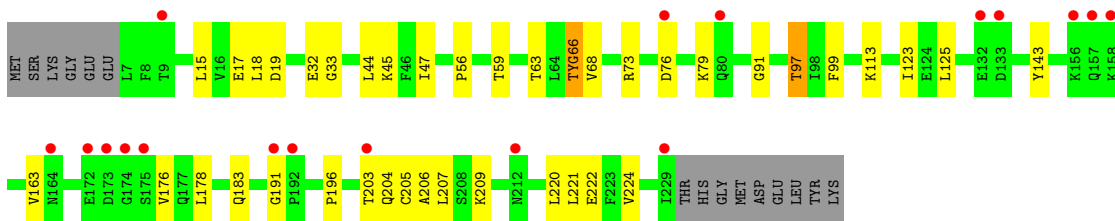
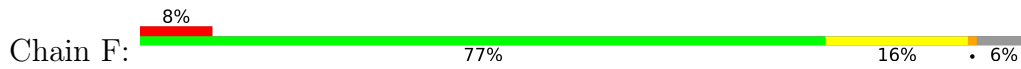




• Molecule 1: Green fluorescent protein



• Molecule 1: Green fluorescent protein



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	88.18Å 128.84Å 147.89Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.83 – 1.90 19.84 – 1.90	Depositor EDS
% Data completeness (in resolution range)	99.7 (19.83-1.90) 100.0 (19.84-1.90)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	5.15 (at 1.90Å)	Xtrriage
Refinement program	CNS 1.1	Depositor
R, $R_{free}$	0.232 , 0.268 0.226 , 0.260	Depositor DCC
$R_{free}$ test set	10643 reflections (8.02%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	16.7	Xtrriage
Anisotropy	0.089	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.38 , 61.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.40$ , $\langle L^2 \rangle = 0.22$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.91	EDS
Total number of atoms	11790	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	20.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 13.16% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: CRO

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	0.34	0/1790	0.65	0/2420
1	B	0.33	0/1790	0.64	0/2420
1	C	0.32	0/1790	0.63	0/2420
1	D	0.33	0/1790	0.65	1/2420 (0.0%)
1	E	0.31	0/1790	0.63	0/2420
1	F	0.33	0/1790	0.65	1/2420 (0.0%)
All	All	0.33	0/10740	0.64	2/14520 (0.0%)

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	1	0
1	B	1	0
1	C	1	0
1	D	1	0
1	E	1	0
1	F	1	0
All	All	6	0

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	D	97	THR	N-CA-C	-5.05	97.37	111.00
1	F	97	THR	N-CA-C	-5.01	97.48	111.00

5 of 6 chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	A	66	CRO	CB1
1	B	66	CRO	CB1
1	C	66	CRO	CB1
1	D	66	CRO	CB1
1	E	66	CRO	CB1

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	1772	0	1724	42	0
1	B	1772	0	1724	53	0
1	C	1772	0	1724	36	0
1	D	1772	0	1724	34	0
1	E	1772	0	1724	41	0
1	F	1772	0	1724	40	0
2	A	196	0	0	3	0
2	B	197	0	0	9	0
2	C	189	0	0	4	0
2	D	188	0	0	3	0
2	E	196	0	0	1	0
2	F	192	0	0	2	0
All	All	11790	0	10344	217	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 10.

The worst 5 of 217 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:A:221:LEU:HD22	1:B:221:LEU:HD23	1.30	1.14
1:A:163:VAL:HB	1:A:183:GLN:HG2	1.43	1.01
1:A:96:ARG:HG2	1:A:183:GLN:HB2	1.43	0.98
1:E:221:LEU:HD21	1:E:223:PHE:CE2	2.02	0.94
1:E:221:LEU:HD13	1:F:221:LEU:HD22	1.50	0.92

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	216/236 (92%)	209 (97%)	7 (3%)	0	100	100
1	B	216/236 (92%)	215 (100%)	1 (0%)	0	100	100
1	C	216/236 (92%)	211 (98%)	5 (2%)	0	100	100
1	D	216/236 (92%)	212 (98%)	4 (2%)	0	100	100
1	E	216/236 (92%)	211 (98%)	5 (2%)	0	100	100
1	F	216/236 (92%)	212 (98%)	4 (2%)	0	100	100
All	All	1296/1416 (92%)	1270 (98%)	26 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 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	193/206 (94%)	190 (98%)	3 (2%)	62	60
1	B	193/206 (94%)	190 (98%)	3 (2%)	62	60
1	C	193/206 (94%)	190 (98%)	3 (2%)	62	60
1	D	193/206 (94%)	191 (99%)	2 (1%)	76	76
1	E	193/206 (94%)	189 (98%)	4 (2%)	53	48
1	F	193/206 (94%)	192 (100%)	1 (0%)	88	89

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
All	All	1158/1236 (94%)	1142 (99%)	16 (1%)	67 65

5 of 16 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	180	ASP
1	E	168	ARG
1	C	184	GLN
1	E	117	ASP
1	C	180	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
1	E	204	GLN
1	F	204	GLN
1	D	159	ASN
1	D	184	GLN
1	D	204	GLN

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

6 non-standard protein/DNA/RNA residues 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
1	CRO	B	66	1	23,23,24	2.90	9 (39%)	30,32,34	2.72	8 (26%)
1	CRO	D	66	1	23,23,24	2.91	9 (39%)	30,32,34	2.66	9 (30%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
1	CRO	C	66	1	23,23,24	2.89	9 (39%)	30,32,34	2.65	7 (23%)
1	CRO	F	66	1	23,23,24	2.80	9 (39%)	30,32,34	2.66	8 (26%)
1	CRO	E	66	1	23,23,24	2.86	9 (39%)	30,32,34	2.71	8 (26%)
1	CRO	A	66	1	23,23,24	2.88	8 (34%)	30,32,34	2.58	8 (26%)

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
1	CRO	B	66	1	1/1/6/8	2/12/31/32	0/2/2/2
1	CRO	D	66	1	1/1/6/8	2/12/31/32	0/2/2/2
1	CRO	C	66	1	1/1/6/8	2/12/31/32	0/2/2/2
1	CRO	F	66	1	1/1/6/8	2/12/31/32	0/2/2/2
1	CRO	E	66	1	1/1/6/8	2/12/31/32	0/2/2/2
1	CRO	A	66	1	1/1/6/8	2/12/31/32	0/2/2/2

The worst 5 of 53 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	66	CRO	C1-N2	9.07	1.45	1.32
1	D	66	CRO	C1-N2	9.07	1.45	1.32
1	C	66	CRO	C1-N2	9.03	1.45	1.32
1	B	66	CRO	C1-N2	8.89	1.45	1.32
1	F	66	CRO	C1-N2	8.78	1.45	1.32

The worst 5 of 48 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	66	CRO	C2-N3-C1	10.12	113.09	107.97
1	F	66	CRO	C2-N3-C1	10.04	113.05	107.97
1	E	66	CRO	C2-N3-C1	10.00	113.03	107.97
1	C	66	CRO	C2-N3-C1	9.71	112.88	107.97
1	D	66	CRO	C2-N3-C1	9.69	112.87	107.97

5 of 6 chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	A	66	CRO	CB1

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Mol	Chain	Res	Type	Atom
1	B	66	CRO	CB1
1	C	66	CRO	CB1
1	D	66	CRO	CB1
1	E	66	CRO	CB1

5 of 12 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	66	CRO	C3-CA3-N3-C2
1	D	66	CRO	C3-CA3-N3-C2
1	B	66	CRO	C3-CA3-N3-C2
1	C	66	CRO	C3-CA3-N3-C2
1	E	66	CRO	C3-CA3-N3-C2

There are no ring outliers.

4 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	B	66	CRO	1	0
1	C	66	CRO	1	0
1	F	66	CRO	1	0
1	A	66	CRO	1	0

## 5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

There are no ligands in this entry.

## 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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	220/236 (93%)	0.21	6 (2%) 54 57	9, 17, 30, 45	5 (2%)
1	B	220/236 (93%)	0.38	10 (4%) 33 36	11, 19, 31, 41	5 (2%)
1	C	220/236 (93%)	0.38	11 (5%) 28 32	9, 18, 32, 48	5 (2%)
1	D	220/236 (93%)	0.25	10 (4%) 33 36	9, 17, 30, 37	5 (2%)
1	E	220/236 (93%)	0.42	15 (6%) 17 19	10, 20, 37, 52	5 (2%)
1	F	220/236 (93%)	0.36	18 (8%) 11 13	9, 18, 34, 47	5 (2%)
All	All	1320/1416 (93%)	0.33	70 (5%) 26 29	9, 18, 33, 52	30 (2%)

The worst 5 of 70 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	F	173	ASP	5.2
1	B	9	THR	5.0
1	D	157	GLN	4.9
1	C	173	ASP	4.5
1	A	173	ASP	4.5

### 6.2 Non-standard residues in protein, DNA, RNA chains [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	CRO	E	66	22/23	0.90	0.15	13,14,19,28	0
1	CRO	C	66	22/23	0.91	0.12	11,14,20,29	0
1	CRO	B	66	22/23	0.91	0.13	12,15,18,28	0
1	CRO	F	66	22/23	0.91	0.13	11,14,18,27	0

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
1	CRO	D	66	22/23	0.92	0.13	10,13,18,27	0
1	CRO	A	66	22/23	0.93	0.12	9,12,16,26	0

### 6.3 Carbohydrates [i](#)

There are no monosaccharides in this entry.

### 6.4 Ligands [i](#)

There are no ligands in this entry.

### 6.5 Other polymers [i](#)

There are no such residues in this entry.