



# Full wwPDB X-ray Structure Validation Report ⓘ

May 29, 2020 – 08:12 am BST

PDB ID : 5TL7  
Title : Crystal structure of SARS-CoV papain-like protease in complex with C-terminal domain mouse ISG15  
Authors : Daczkowski, C.D.; Dzimianski, J.V.; Pegan, S.D.  
Deposited on : 2016-10-10  
Resolution : 2.44 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](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.

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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)  
Xtriage (Phenix) : 1.13  
EDS : 2.11  
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) : 2.11

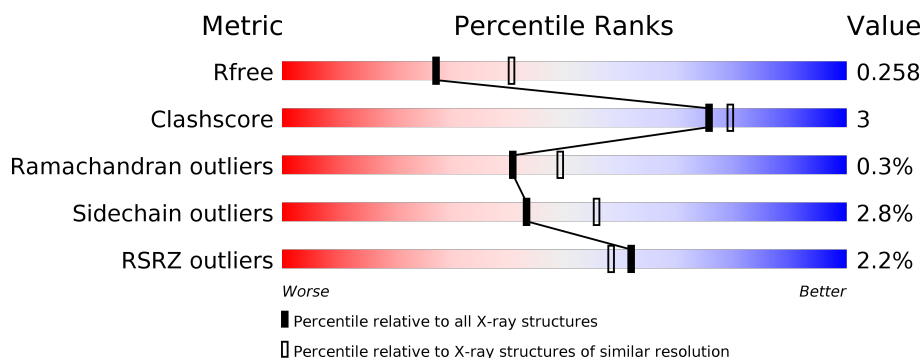
# 1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.44 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	1564 (2.46-2.42)
Clashscore	141614	1631 (2.46-2.42)
Ramachandran outliers	138981	1617 (2.46-2.42)
Sidechain outliers	138945	1617 (2.46-2.42)
RSRZ outliers	127900	1547 (2.46-2.42)

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  $\geq 3$ , 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	79	<div> <div>%</div> <div> <div></div> <div>92%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> <div> <div></div> <div>92%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> </div>
1	C	79	<div> <div>%</div> <div> <div></div> <div>90%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> <div> <div></div> <div>90%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> </div>
2	B	319	<div> <div>3%</div> <div> <div></div> <div>91%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> <div> <div></div> <div>91%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> </div>
2	D	319	<div> <div>2%</div> <div> <div></div> <div>86%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> <div> <div></div> <div>86%</div> <div>6%</div> <div>8%</div> <div>11%</div> </div> </div>

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 6350 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 Ubiquitin-like protein ISG15.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	77	Total	C	N	O	S	0	0	0
			635	403	115	115	2			
1	C	77	Total	C	N	O	S	0	0	0
			635	403	115	115	2			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	77	MET	-	initiating methionine	UNP Q64339
A	155	AYE	GLY	engineered mutation	UNP Q64339
C	77	MET	-	initiating methionine	UNP Q64339
C	155	AYE	GLY	engineered mutation	UNP Q64339

- Molecule 2 is a protein called Replicase polypeptide 1ab.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	316	Total	C	N	O	S	0	0	0
			2490	1580	414	478	18			
2	D	313	Total	C	N	O	S	0	0	0
			2466	1565	411	473	17			

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-2	MET	-	initiating methionine	UNP P0C6X7
B	-1	ALA	-	expression tag	UNP P0C6X7
B	0	SER	-	expression tag	UNP P0C6X7
B	1	MET	-	expression tag	UNP P0C6X7
D	-2	MET	-	initiating methionine	UNP P0C6X7
D	-1	ALA	-	expression tag	UNP P0C6X7
D	0	SER	-	expression tag	UNP P0C6X7
D	1	MET	-	expression tag	UNP P0C6X7

- Molecule 3 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	B	1	Total	Zn	0	0
			1	1		
3	D	1	Total	Zn	0	0
			1	1		

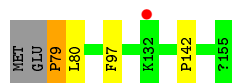
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	18	Total	O	0	0
			18	18		
4	B	49	Total	O	0	0
			49	49		
4	C	7	Total	O	0	0
			7	7		
4	D	48	Total	O	0	0
			48	48		

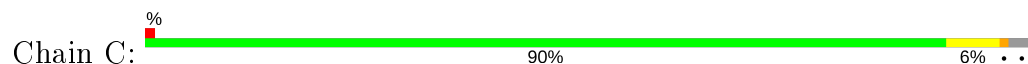
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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.

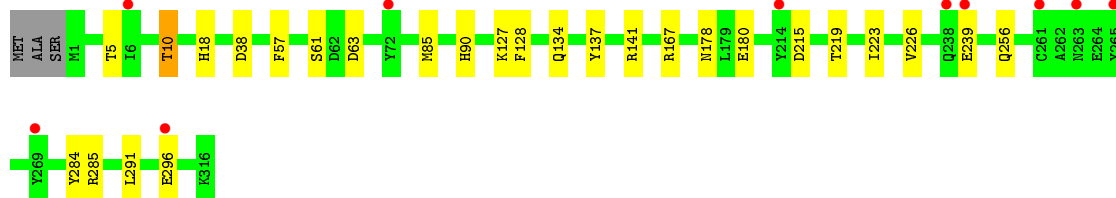
- Molecule 1: Ubiquitin-like protein ISG15



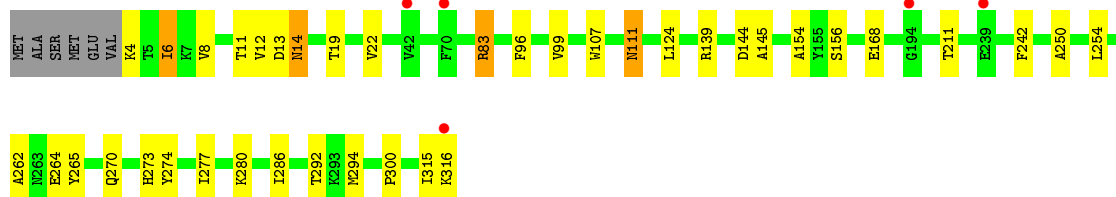
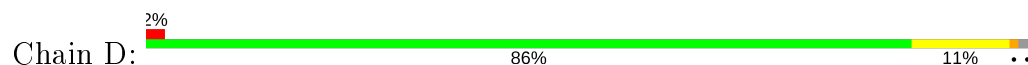
- Molecule 1: Ubiquitin-like protein ISG15



- Molecule 2: Replicase polyprotein 1ab



- Molecule 2: Replicase polyprotein 1ab



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	75.98 Å 98.19 Å 106.64 Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	72.23 – 2.44 46.86 – 2.44	Depositor EDS
% Data completeness (in resolution range)	98.9 (72.23-2.44) 98.9 (46.86-2.44)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.09 (at 2.45 Å)	Xtriage
Refinement program	REFMAC 5.8.0073	Depositor
R, $R_{free}$	0.192 , 0.267 0.194 , 0.258	Depositor DCC
$R_{free}$ test set	1529 reflections (5.11%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	55.3	Xtriage
Anisotropy	0.525	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 52.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.51$ , $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	6350	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	64.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.82% 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: AYE, ZN

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	0.58	0/643	0.79	0/863
1	C	0.59	0/643	0.72	0/863
2	B	0.59	0/2545	0.72	2/3452 (0.1%)
2	D	0.63	0/2521	0.77	2/3420 (0.1%)
All	All	0.60	0/6352	0.75	4/8598 (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
2	D	0	1

There are no bond length outliers.

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	83	ARG	NE-CZ-NH2	-9.02	115.79	120.30
2	B	167	ARG	NE-CZ-NH2	-7.37	116.61	120.30
2	B	167	ARG	NE-CZ-NH1	6.71	123.65	120.30
2	D	83	ARG	NE-CZ-NH1	6.50	123.55	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	D	4	LYS	Peptide

## 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	635	0	643	2	0
1	C	635	0	643	3	0
2	B	2490	0	2437	12	0
2	D	2466	0	2410	22	0
3	B	1	0	0	0	0
3	D	1	0	0	0	0
4	A	18	0	0	0	0
4	B	49	0	0	3	0
4	C	7	0	0	0	0
4	D	48	0	0	0	0
All	All	6350	0	6133	38	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 3.

All (38) 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:D:83:ARG:NH2	2:D:154:ALA:O	2.27	0.68
2:B:38:ASP:OD1	2:B:90:HIS:NE2	2.29	0.64
1:C:86:ASN:HB2	1:C:90:HIS:O	1.97	0.64
2:D:6:ILE:HG22	2:D:22:VAL:CG2	2.27	0.63
2:D:315:ILE:O	2:D:316:LYS:CB	2.52	0.57
2:D:107:TRP:HA	2:D:111:ASN:HD21	1.70	0.56
2:B:10:THR:HG22	2:B:18:HIS:HB2	1.88	0.56
2:D:262:ALA:HB3	2:D:277:ILE:CG2	2.38	0.54
2:B:141:ARG:NH1	4:B:505:HOH:O	2.40	0.53
2:B:285:ARG:NH1	4:B:504:HOH:O	2.39	0.53
1:A:79:PRO:HD2	1:A:97:PHE:CE2	2.44	0.52
2:B:137:TYR:OH	4:B:501:HOH:O	2.19	0.51
2:B:128:PHE:H	2:B:134:GLN:NE2	2.08	0.51
1:A:80:LEU:CD1	1:A:142:PRO:HG3	2.42	0.49
2:D:111:ASN:C	2:D:111:ASN:HD22	2.16	0.49
2:B:180:GLU:H	2:B:180:GLU:CD	2.16	0.49
2:D:96:PHE:CD1	2:D:145:ALA:HB3	2.48	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:D:264:GLU:O	2:D:274:TYR:HA	2.13	0.48
2:B:57:PHE:CZ	2:B:85:MET:HG2	2.48	0.47
2:D:6:ILE:HG22	2:D:22:VAL:HG22	1.96	0.47
2:D:139:ARG:NH2	2:D:144:ASP:OD2	2.46	0.46
2:D:265:TYR:HA	2:D:273:HIS:O	2.17	0.45
2:D:11:THR:HG22	2:D:13:ASP:H	1.82	0.44
2:D:99:VAL:HG11	2:D:286:ILE:HG23	1.99	0.44
2:D:292:THR:HG22	2:D:294:MET:HE2	1.98	0.44
2:D:254:LEU:CD1	2:D:277:ILE:HG21	2.48	0.44
2:D:11:THR:HG21	2:D:14:ASN:HA	1.99	0.44
2:B:215:ASP:O	2:B:219:THR:HG23	2.16	0.44
2:D:124:LEU:HD22	2:D:242:PHE:CG	2.54	0.43
2:D:315:ILE:O	2:D:316:LYS:HB3	2.19	0.43
2:B:127:LYS:HD2	2:B:134:GLN:OE1	2.18	0.42
1:C:79:PRO:HD2	1:C:97:PHE:HE1	1.84	0.42
2:D:12:VAL:O	2:D:12:VAL:HG12	2.20	0.41
2:D:250:ALA:O	2:D:300:PRO:HA	2.21	0.41
2:B:284:TYR:CD2	2:B:291:LEU:HD11	2.56	0.41
2:D:111:ASN:C	2:D:111:ASN:ND2	2.74	0.41
2:B:223:ILE:HG13	2:B:223:ILE:O	2.21	0.41
1:C:121:TRP:CE2	2:D:168:GLU:HG3	2.55	0.41

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	74/79 (94%)	71 (96%)	3 (4%)	0	100	100
1	C	74/79 (94%)	73 (99%)	1 (1%)	0	100	100
2	B	314/319 (98%)	302 (96%)	11 (4%)	1 (0%)	41	49
2	D	311/319 (98%)	295 (95%)	15 (5%)	1 (0%)	41	49

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
All	All	773/796 (97%)	741 (96%)	30 (4%)	2 (0%)	41 49

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	D	14	ASN
2	B	226	VAL

### 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	71/73 (97%)	70 (99%)	1 (1%)	67 78
1	C	71/73 (97%)	69 (97%)	2 (3%)	43 56
2	B	273/275 (99%)	265 (97%)	8 (3%)	42 54
2	D	270/275 (98%)	262 (97%)	8 (3%)	41 53
All	All	685/696 (98%)	666 (97%)	19 (3%)	43 56

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

Mol	Chain	Res	Type
1	A	79	PRO
2	B	5	THR
2	B	10	THR
2	B	61	SER
2	B	63	ASP
2	B	178	ASN
2	B	239	GLU
2	B	256	GLN
2	B	296	GLU
1	C	86	ASN
1	C	137	GLU
2	D	6	ILE
2	D	8	VAL

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Mol	Chain	Res	Type
2	D	19	THR
2	D	111	ASN
2	D	156	SER
2	D	211	THR
2	D	270	GLN
2	D	280	LYS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (18) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	100	GLN
1	A	119	GLN
2	B	14	ASN
2	B	89	ASN
2	B	98	GLN
2	B	123	GLN
2	B	178	ASN
2	B	216	ASN
2	B	233	GLN
2	B	237	GLN
2	B	256	GLN
1	C	86	ASN
2	D	98	GLN
2	D	111	ASN
2	D	123	GLN
2	D	187	ASN
2	D	233	GLN
2	D	270	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 carbohydrates in this entry.

## 5.6 Ligand geometry

Of 2 ligands modelled in this entry, 2 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

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

There are no such residues in this entry.

## 5.8 Polymer linkage issues

There are no chain breaks in this entry.

## 6 Fit of model and data ⓘ

### 6.1 Protein, DNA and RNA chains ⓘ

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	76/79 (96%)	-0.08	1 (1%) 77 75	48, 60, 76, 103	0
1	C	76/79 (96%)	-0.10	1 (1%) 77 75	52, 66, 92, 109	0
2	B	316/319 (99%)	0.00	10 (3%) 47 44	45, 62, 97, 112	0
2	D	313/319 (98%)	-0.15	5 (1%) 72 69	43, 59, 86, 108	0
All	All	781/796 (98%)	-0.07	17 (2%) 62 58	43, 61, 89, 112	0

All (17) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	122	LEU	4.1
2	D	194	GLY	3.9
2	B	214	TYR	3.2
2	B	6	ILE	3.2
2	D	42	VAL	3.0
2	B	263	ASN	2.9
2	B	239	GLU	2.6
2	B	265	TYR	2.5
2	B	238	GLN	2.5
2	B	261	CYS	2.4
2	D	239	GLU	2.4
2	B	296	GLU	2.3
2	D	316	LYS	2.3
2	D	70	PHE	2.2
2	B	269	TYR	2.1
2	B	72	TYR	2.1
1	A	132	LYS	2.0

### 6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

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. 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( $\text{\AA}^2$ )	Q<0.9
3	ZN	D	401	1/1	0.95	0.07	74,74,74,74	0
3	ZN	B	401	1/1	0.99	0.12	81,81,81,81	0

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

There are no such residues in this entry.