



# Full wwPDB X-ray Structure Validation Report ⓘ

May 14, 2020 – 08:03 pm BST

PDB ID : 4WUR  
Title : The crystal structure of the MERS-CoV papain-like protease (C111S) with human ubiquitin  
Authors : Lei, J.; Hilgenfeld, R.  
Deposited on : 2014-11-03  
Resolution : 3.16 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.

---

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

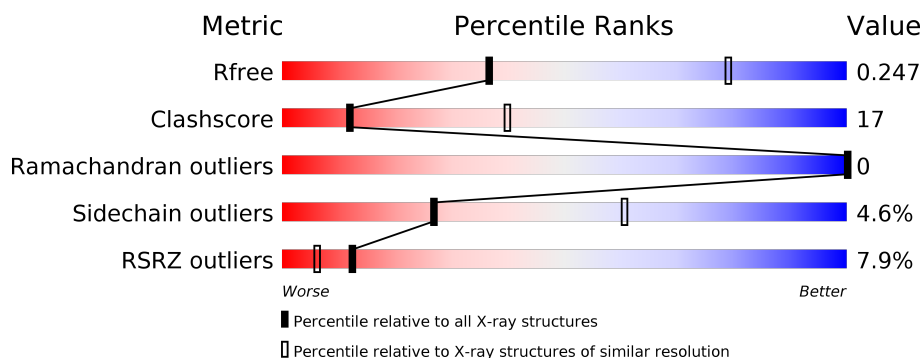
# 1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.16 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	1665 (3.20-3.12)
Clashscore	141614	1804 (3.20-3.12)
Ramachandran outliers	138981	1770 (3.20-3.12)
Sidechain outliers	138945	1769 (3.20-3.12)
RSRZ outliers	127900	1616 (3.20-3.12)

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	326	<div> <div>6%</div> <div>72%</div> <div>24%</div> <div>••</div> </div>
2	B	76	<div> <div>16%</div> <div>58%</div> <div>30%</div> <div>9%</div> <div>•</div> </div>

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
3	IPA	A	401	-	-	-	X

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 2845 atoms, of which 16 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 Papain-like protease.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	317	Total	C	N	O	S	6	0	0
			2338	1484	392	445	17			

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-5	GLY	-	expression tag	UNP K9N7C7
A	-4	SER	-	expression tag	UNP K9N7C7
A	-3	HIS	-	expression tag	UNP K9N7C7
A	-2	MET	-	expression tag	UNP K9N7C7
A	-1	ALA	-	expression tag	UNP K9N7C7
A	0	SER	-	expression tag	UNP K9N7C7
A	92	GLY	LYS	conflict	UNP K9N7C7
A	111	SER	CYS	engineered mutation	UNP K9N7C7
A	236	LEU	ILE	conflict	UNP K9N7C7

- Molecule 2 is a protein called Polyubiquitin-B.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	B	74	Total	C	N	O	1	0	0
			482	293	89	100			

- Molecule 3 is ISOPROPYL ALCOHOL (three-letter code: IPA) (formula: C<sub>3</sub>H<sub>8</sub>O).



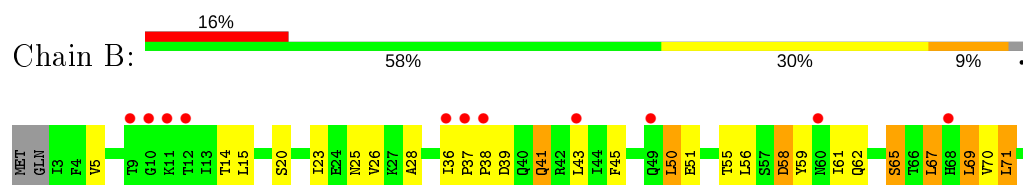
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	H	O	0	0
			12	3	8	1		
3	A	1	Total	C	H	O	0	0
			12	3	8	1		

- Molecule 4 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total	Zn	0	0
			1	1		



- Molecule 1: Papain-like protease



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 63	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	138.14 Å   138.14 Å   57.59 Å 90.00°   90.00°   120.00°	Depositor
Resolution (Å)	39.88 – 3.16 18.61 – 3.16	Depositor EDS
% Data completeness (in resolution range)	99.3 (39.88-3.16) 99.9 (18.61-3.16)	Depositor EDS
$R_{merge}$	0.13	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.54 (at 3.15 Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.4_1496)	Depositor
R, $R_{free}$	0.208 , 0.252 0.209 , 0.247	Depositor DCC
$R_{free}$ test set	532 reflections (4.89%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	88.9	Xtriage
Anisotropy	0.137	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 95.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	0.039 for h,-h-k,-l	Xtriage
$F_o, F_c$ correlation	0.91	EDS
Total number of atoms	2845	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	108.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.04% 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: ZN, IPA

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	0.61	0/2388	0.86	1/3254 (0.0%)
2	B	0.44	0/487	0.96	2/654 (0.3%)
All	All	0.58	0/2875	0.88	3/3908 (0.1%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	20	SER	N-CA-C	-7.80	89.95	111.00
2	B	69	LEU	CA-CB-CG	-5.76	102.05	115.30
1	A	56	LEU	CA-CB-CG	5.14	127.13	115.30

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	2338	0	2177	65	1
2	B	482	0	410	31	0
3	A	8	16	16	1	0
4	A	1	0	0	0	0
All	All	2829	16	2603	93	1



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 17.

All (93) 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:43:LEU:HD13	2:B:67:LEU:HD23	1.36	1.05
1:A:185:MET:HE3	1:A:187:TRP:HE1	1.41	0.82
1:A:163:PRO:HG2	2:B:74:ARG:HD2	1.66	0.77
2:B:43:LEU:HD13	2:B:67:LEU:CD2	2.16	0.76
2:B:5:VAL:HG22	2:B:67:LEU:CB	2.17	0.73
1:A:61:THR:HG22	1:A:63:ASP:H	1.53	0.72
2:B:62:GLN:O	2:B:65:SER:HB2	1.91	0.70
1:A:148:PHE:CE2	1:A:152:ILE:HD11	2.26	0.69
2:B:36:ILE:CG2	2:B:37:PRO:HD2	2.23	0.69
2:B:55:THR:O	2:B:58:ASP:HB2	1.93	0.68
1:A:185:MET:CE	1:A:187:TRP:HE1	2.07	0.68
2:B:5:VAL:HG22	2:B:67:LEU:HB2	1.77	0.65
1:A:172:THR:HG22	2:B:51:GLU:OE2	1.97	0.64
1:A:61:THR:HG22	1:A:63:ASP:N	2.11	0.63
1:A:6:VAL:HG21	1:A:54:LEU:HG	1.80	0.63
1:A:272:ILE:HG13	1:A:275:ALA:HB3	1.80	0.63
2:B:5:VAL:HA	2:B:67:LEU:O	1.99	0.63
1:A:90:VAL:HG22	1:A:93:TRP:CD2	2.33	0.63
2:B:45:PHE:HB3	2:B:50:LEU:HD11	1.82	0.62
2:B:55:THR:O	2:B:58:ASP:N	2.31	0.61
1:A:280:VAL:HG22	1:A:293:ASP:OD2	2.00	0.61
2:B:26:VAL:CG1	2:B:56:LEU:HD11	2.31	0.60
1:A:272:ILE:CG1	1:A:275:ALA:HB3	2.31	0.60
1:A:106:LEU:HB2	1:A:294:SER:HB3	1.84	0.59
1:A:90:VAL:HG22	1:A:93:TRP:CE3	2.37	0.59
2:B:5:VAL:HG22	2:B:67:LEU:HB3	1.83	0.59
1:A:90:VAL:HG21	1:A:153:MET:HE1	1.85	0.58
1:A:6:VAL:CG2	1:A:54:LEU:HG	2.34	0.58
1:A:313:PRO:O	1:A:315:GLN:NE2	2.32	0.58
1:A:149:ILE:HD12	3:A:401:IPA:H12	1.86	0.57
1:A:108:ASP:HB3	1:A:161:GLY:HA2	1.87	0.57
2:B:36:ILE:HG23	2:B:37:PRO:HD2	1.87	0.57
2:B:14:THR:C	2:B:15:LEU:HD12	2.26	0.56
1:A:255:VAL:O	1:A:302:ASP:HA	2.05	0.56
1:A:83:PHE:CE1	1:A:151:LEU:HG	2.41	0.56
1:A:183:ALA:HA	1:A:240:THR:O	2.06	0.55
1:A:106:LEU:HD12	1:A:278:HIS:HE1	1.71	0.55

*Continued on next page...*

*Continued from previous page...*

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:37:PRO:O	2:B:41:GLN:HG2	2.08	0.54
1:A:185:MET:HE3	1:A:201:LEU:HD12	1.90	0.53
1:A:269:PHE:CE1	1:A:277:GLY:HA3	2.44	0.53
1:A:237:VAL:HG12	1:A:237:VAL:O	2.09	0.52
2:B:23:ILE:O	2:B:26:VAL:HG22	2.09	0.52
2:B:59:TYR:HB2	2:B:61:ILE:HG13	1.91	0.52
1:A:151:LEU:HD22	1:A:155:TYR:CE2	2.44	0.51
1:A:226:CYS:N	1:A:230:GLY:O	2.34	0.51
2:B:36:ILE:HD13	2:B:71:LEU:CD2	2.39	0.51
1:A:191:CYS:SG	1:A:193:VAL:HG22	2.51	0.51
1:A:44:ILE:HG13	1:A:44:ILE:O	2.10	0.51
1:A:35:PHE:HB3	1:A:40:ILE:HD13	1.94	0.50
1:A:193:VAL:HG23	1:A:194:CYS:H	1.76	0.50
1:A:240:THR:HA	1:A:315:GLN:O	2.12	0.50
1:A:148:PHE:CZ	1:A:152:ILE:HD11	2.47	0.50
1:A:212:VAL:HG13	1:A:217:ASP:HB2	1.94	0.49
1:A:106:LEU:HB2	1:A:294:SER:CB	2.42	0.49
1:A:90:VAL:HG13	1:A:90:VAL:O	2.13	0.48
1:A:71:LEU:HD12	1:A:131:PRO:HB2	1.94	0.48
1:A:80:LEU:HD22	1:A:84:TYR:CZ	2.48	0.48
2:B:55:THR:HG22	2:B:58:ASP:OD2	2.14	0.48
1:A:224:TYR:O	1:A:231:GLU:HA	2.14	0.48
2:B:14:THR:O	2:B:15:LEU:HD12	2.14	0.47
1:A:263:PHE:CE1	1:A:284:LEU:HD11	2.50	0.46
1:A:35:PHE:HB2	1:A:54:LEU:HD22	1.96	0.46
2:B:36:ILE:HG22	2:B:37:PRO:HD2	1.98	0.46
1:A:90:VAL:O	1:A:90:VAL:CG1	2.64	0.45
1:A:97:VAL:HG22	1:A:102:ARG:HG2	1.97	0.45
2:B:25:ASN:HA	2:B:28:ALA:HB3	1.98	0.45
1:A:174:LEU:HA	1:A:174:LEU:HD23	1.58	0.45
2:B:69:LEU:HD12	2:B:70:VAL:H	1.81	0.45
2:B:69:LEU:HD12	2:B:70:VAL:N	2.32	0.45
1:A:185:MET:HB2	1:A:239:HIS:CD2	2.52	0.45
1:A:226:CYS:SG	1:A:227:GLN:N	2.91	0.44
2:B:45:PHE:CE2	2:B:61:ILE:HG12	2.53	0.43
1:A:152:ILE:HG21	1:A:152:ILE:HD13	1.83	0.43
1:A:61:THR:CG2	1:A:62:ALA:N	2.81	0.43
1:A:60:LEU:HA	1:A:60:LEU:HD23	1.67	0.42
1:A:191:CYS:SG	1:A:193:VAL:CG2	3.08	0.42
1:A:208:CYS:HA	1:A:245:LEU:O	2.18	0.42
1:A:186:VAL:O	1:A:236:LEU:HD12	2.20	0.42

*Continued on next page...*

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:193:VAL:HG23	1:A:194:CYS:N	2.34	0.42
1:A:90:VAL:HG22	1:A:93:TRP:CE2	2.55	0.42
1:A:307:VAL:HG11	1:A:310:VAL:HG22	2.02	0.42
1:A:109:ASN:HA	2:B:76:GLY:OXT	2.19	0.42
2:B:38:PRO:HA	2:B:41:GLN:CG	2.49	0.42
1:A:268:VAL:HG11	1:A:305:CYS:HB2	2.02	0.42
1:A:44:ILE:HA	1:A:45:PRO:HD3	1.86	0.42
2:B:55:THR:HG23	2:B:58:ASP:H	1.83	0.42
1:A:68:LEU:HD12	1:A:72:TYR:CD2	2.55	0.42
1:A:204:LEU:HA	1:A:204:LEU:HD12	1.83	0.41
2:B:36:ILE:CD1	2:B:71:LEU:HD21	2.51	0.41
1:A:280:VAL:CG2	1:A:293:ASP:OD2	2.67	0.40
1:A:71:LEU:HG	1:A:132:ALA:HB2	2.03	0.40
1:A:168:ARG:HH21	1:A:168:ARG:HD3	1.74	0.40
1:A:40:ILE:HD12	1:A:49:GLN:HE21	1.86	0.40

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:17:THR:OG1	1:A:99:ASP:OD2[4_874]	2.12	0.08

## 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	315/326 (97%)	302 (96%)	13 (4%)	0	100	100
2	B	72/76 (95%)	67 (93%)	5 (7%)	0	100	100
All	All	387/402 (96%)	369 (95%)	18 (5%)	0	100	100

There are no Ramachandran outliers to report.

### 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	240/280 (86%)	234 (98%)	6 (2%)	47	75
2	B	41/68 (60%)	34 (83%)	7 (17%)	2	9
All	All	281/348 (81%)	268 (95%)	13 (5%)	27	60

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	17	THR
1	A	44	ILE
1	A	46	ASP
1	A	185	MET
1	A	276	VAL
1	A	302	ASP
2	B	39	ASP
2	B	41	GLN
2	B	50	LEU
2	B	58	ASP
2	B	65	SER
2	B	67	LEU
2	B	71	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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 [i](#)

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 3 ligands modelled in this entry, 1 is monoatomic - leaving 2 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	$\# Z  > 2$
3	IPA	A	402	-	3,3,3	0.55	0	3,3,3	0.31	0
3	IPA	A	401	-	3,3,3	0.54	0	3,3,3	0.59	0

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.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	401	IPA	1	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 ⓘ

### 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	317/326 (97%)	0.08	19 (5%) 21 11	54, 94, 158, 226	6 (1%)
2	B	74/76 (97%)	0.91	12 (16%) 1 1	95, 159, 195, 227	1 (1%)
All	All	391/402 (97%)	0.23	31 (7%) 12 6	54, 102, 178, 227	7 (1%)

All (31) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	76	GLY	5.0
1	A	233	HIS	4.2
2	B	37	PRO	4.1
1	A	223	THR	3.8
1	A	227	GLN	3.8
2	B	12	THR	3.7
1	A	232	ARG	3.6
2	B	11	LYS	3.6
2	B	9	THR	3.6
1	A	47	GLU	3.4
2	B	36	ILE	3.4
2	B	10	GLY	3.2
1	A	224	TYR	2.9
1	A	225	VAL	2.8
1	A	15	PHE	2.8
2	B	38	PRO	2.7
2	B	68	HIS	2.6
1	A	228	CYS	2.5
1	A	300	THR	2.5
1	A	318	SER	2.5
2	B	60	ASN	2.4
1	A	3	THR	2.4
1	A	319	SER	2.4
1	A	302	ASP	2.4

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
1	A	231	GLU	2.3
1	A	258	SER	2.3
1	A	235	GLN	2.2
2	B	49	GLN	2.2
2	B	43	LEU	2.1
1	A	287	GLY	2.0
1	A	207	CYS	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 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(Å <sup>2</sup> )	Q<0.9
3	IPA	A	401	4/4	0.74	0.67	61,116,145,149	12
3	IPA	A	402	4/4	0.82	0.30	89,119,152,158	0
4	ZN	A	403	1/1	0.86	0.07	172,172,172,172	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.