



# Full wwPDB X-ray Structure Validation Report

Feb 28, 2014 – 03:30 PM GMT

PDB ID : 4O4K  
Title : DNA Double-Strand Break Repair Pathway Choice Is Directed by Distinct MRE11 Nuclease Activities  
Authors : Shibata, A.; Moiani, D.; Arvai, A.S.; Perry, J.; Harding, S.M.; Genois, M.; Maity, R.; Rossum-Fikkert, S.; Kertokallio, A.; Romoli, F.; Ismail, A.; Ismalaj, E.; Petricci, E.; Neale, M.J.; Bristow, R.G.; Masson, J.; Wyman, C.; Jeggo, P.A.; Tainer, J.A.  
Deposited on : 2013-12-18  
Resolution : 2.10 Å(reported)

This is a full wwPDB 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 <http://wwpdb.org/ValidationPDFNotes.html>

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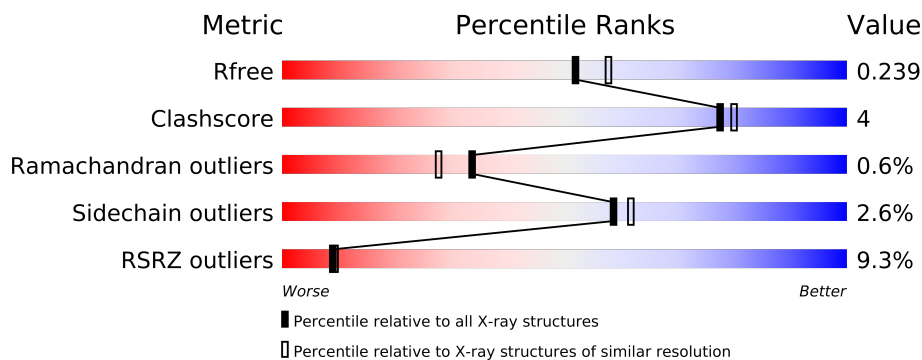
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.15 2013  
Xtriage (Phenix) : dev-1323  
EDS : stable22639  
Percentile statistics : 21963  
Refmac : 5.8.0049  
CCP4 : 6.3.0 (Settle)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : stable22683

# 1 Overall quality at a glance

The reported resolution of this entry is 2.10 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))
$R_{free}$	66092	3012 (2.10-2.10)
Clashscore	79885	3649 (2.10-2.10)
Ramachandran outliers	78287	3610 (2.10-2.10)
Sidechain outliers	78261	3611 (2.10-2.10)
RSRZ outliers	66119	3013 (2.10-2.10)

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. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	336	
1	B	336	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
2	MN	B	402	-	X
3	2PK	A	403	-	X
3	2PK	B	403	-	X

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 5318 atoms, of which 0 are hydrogen and 0 are deuterium.

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 Exonuclease, putative.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	331	Total	C	N	O	S	0	1	0
			2629	1692	449	482	6			
1	B	321	Total	C	N	O	S	0	0	0
			2524	1629	423	466	6			

There are 26 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-11	MET	-	EXPRESSION TAG	UNP Q9X1X0
A	-10	GLY	-	EXPRESSION TAG	UNP Q9X1X0
A	-9	SER	-	EXPRESSION TAG	UNP Q9X1X0
A	-8	ASP	-	EXPRESSION TAG	UNP Q9X1X0
A	-7	LYS	-	EXPRESSION TAG	UNP Q9X1X0
A	-6	ILE	-	EXPRESSION TAG	UNP Q9X1X0
A	-5	HIS	-	EXPRESSION TAG	UNP Q9X1X0
A	-4	HIS	-	EXPRESSION TAG	UNP Q9X1X0
A	-3	HIS	-	EXPRESSION TAG	UNP Q9X1X0
A	-2	HIS	-	EXPRESSION TAG	UNP Q9X1X0
A	-1	HIS	-	EXPRESSION TAG	UNP Q9X1X0
A	0	HIS	-	EXPRESSION TAG	UNP Q9X1X0
A	1	VAL	-	EXPRESSION TAG	UNP Q9X1X0
B	-11	MET	-	EXPRESSION TAG	UNP Q9X1X0
B	-10	GLY	-	EXPRESSION TAG	UNP Q9X1X0
B	-9	SER	-	EXPRESSION TAG	UNP Q9X1X0
B	-8	ASP	-	EXPRESSION TAG	UNP Q9X1X0
B	-7	LYS	-	EXPRESSION TAG	UNP Q9X1X0
B	-6	ILE	-	EXPRESSION TAG	UNP Q9X1X0
B	-5	HIS	-	EXPRESSION TAG	UNP Q9X1X0
B	-4	HIS	-	EXPRESSION TAG	UNP Q9X1X0
B	-3	HIS	-	EXPRESSION TAG	UNP Q9X1X0
B	-2	HIS	-	EXPRESSION TAG	UNP Q9X1X0
B	-1	HIS	-	EXPRESSION TAG	UNP Q9X1X0
B	0	HIS	-	EXPRESSION TAG	UNP Q9X1X0

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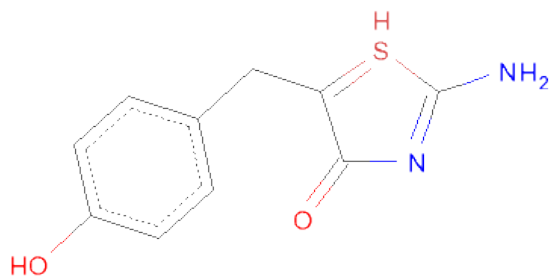
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Chain	Residue	Modelled	Actual	Comment	Reference
B	1	VAL	-	EXPRESSION TAG	UNP Q9X1X0

- Molecule 2 is MANGANESE (II) ION (three-letter code: MN) (formula: Mn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	B	2	Total	Mn	0	0
			2	2		
2	A	2	Total	Mn	0	0
			2	2		

- Molecule 3 is 2-AMINO-5-(4-HYDROXYBENZYL)-4H-1LAMBDA 4 ,3-THIAZOL-4-ONE (three-letter code: 2PK) (formula: C<sub>10</sub>H<sub>10</sub>N<sub>2</sub>O<sub>2</sub>S).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	S	0	0
			15	10	2	2	1		
3	B	1	Total	C	N	O	S	0	0
			15	10	2	2	1		

- Molecule 4 is water.

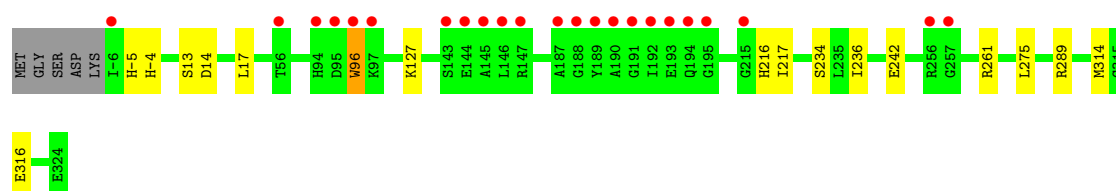
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	76	Total	O	0	0
			76	76		
4	B	55	Total	O	0	0
			55	55		

### 3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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.

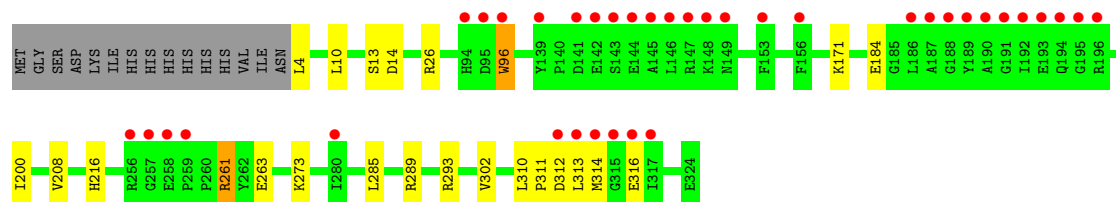
- Molecule 1: Exonuclease, putative

Chain A: 



- Molecule 1: Exonuclease, putative

Chain B: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	47.77Å 113.15Å 80.89Å 90.00° 101.47° 90.00°	Depositor
Resolution (Å)	37.41 – 2.10 37.41 – 2.10	Depositor EDS
% Data completeness (in resolution range)	88.7 (37.41-2.10) 88.6 (37.41-2.10)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.45 (at 2.10Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.4_1496)	Depositor
R, $R_{free}$	0.193 , 0.240 0.195 , 0.239	Depositor DCC
$R_{free}$ test set	1870 reflections (4.30%)	DCC
Wilson B-factor (Å <sup>2</sup> )	40.8	Xtriage
Anisotropy	0.594	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 50.8	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	0 of 46333 reflections	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	5318	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	61.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.94% of the height of the origin peak. No significant pseudotranslation is detected.*

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

## 5 Model quality

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 2PK, MN

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	0.41	0/2694	0.57	0/3650
1	B	0.37	0/2580	0.58	0/3495
All	All	0.39	0/5274	0.57	0/7145

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2629	0	0	9	0
1	B	2524	0	0	8	0
2	A	2	0	0	0	0
2	B	2	0	0	0	0
3	A	15	0	0	1	0
3	B	15	0	0	1	0
4	A	76	0	0	5	0
4	B	55	0	0	1	0
All	All	5318	0	0	19	0

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 4.

All (19) close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:26:ARG:NH2	1:B:314:MET:O	2.15	0.79
1:A:242:GLU:OE1	4:A:526:HOH:O	2.05	0.73
1:A:236:ILE:O	4:A:526:HOH:O	2.09	0.68
1:A:234:SER:OG	4:A:526:HOH:O	2.13	0.66
1:A:127:LYS:NZ	4:A:511:HOH:O	2.35	0.58
1:B:13:SER:OG	1:B:14:ASP:OD2	2.22	0.57
1:B:184:GLU:N	1:B:200:ILE:O	2.39	0.56
1:B:293:ARG:NE	4:B:532:HOH:O	2.39	0.55
1:A:289:ARG:NH2	1:A:316:GLU:OE1	2.40	0.55
1:A:-5:HIS:O	1:A:-4:HIS:ND1	2.44	0.51
1:B:261:ARG:NH1	1:B:263:GLU:OE1	2.46	0.48
1:A:314:MET:N	4:A:537:HOH:O	2.47	0.47
1:A:13:SER:OG	1:A:14:ASP:OD2	2.32	0.47
1:B:96:TRP:N	1:B:96:TRP:CD1	2.83	0.46
1:B:311:PRO:O	1:B:313:LEU:N	2.48	0.46
3:A:403:2PK:OAB	3:A:403:2PK:CAH	2.65	0.45
3:B:403:2PK:CAH	3:B:403:2PK:OAB	2.65	0.45
1:B:289:ARG:NE	1:B:316:GLU:OE1	2.54	0.41
1:A:96:TRP:N	1:A:96:TRP:CD1	2.87	0.41

There are no symmetry-related clashes.

## 5.3 Torsion angles

### 5.3.1 Protein backbone ⓘ

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	330/336 (98%)	313 (95%)	16 (5%)	1 (0%)	50	49
1	B	319/336 (95%)	299 (94%)	17 (5%)	3 (1%)	25	17
All	All	649/672 (97%)	612 (94%)	33 (5%)	4 (1%)	33	28

All (4) Ramachandran outliers are listed below:



Mol	Chain	Res	Type
1	A	216	HIS
1	B	216	HIS
1	B	312	ASP
1	B	208	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	279/298 (94%)	274 (98%)	5 (2%)	71	75
1	B	265/298 (89%)	256 (97%)	9 (3%)	49	49
All	All	544/596 (91%)	530 (97%)	14 (3%)	59	62

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	17	LEU
1	A	96	TRP
1	A	217	ILE
1	A	261	ARG
1	A	275	LEU
1	B	4	LEU
1	B	10	LEU
1	B	96	TRP
1	B	171	LYS
1	B	261	ARG
1	B	273	LYS
1	B	285	LEU
1	B	302	VAL
1	B	310	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 chains 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 6 ligands modelled in this entry, 4 are 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	2PK	A	403	-	14,16,16	3.73	3 (21%)	14,22,22	3.00	5 (35%)
3	2PK	B	403	-	14,16,16	3.73	3 (21%)	14,22,22	2.99	5 (35%)

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
3	2PK	A	403	-	-	1/3/16/16	0/1/2/2
3	2PK	B	403	-	-	1/3/16/16	0/1/2/2

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	403	2PK	CAD-CAO	-11.35	1.35	1.51
3	B	403	2PK	CAD-CAO	-11.30	1.35	1.51
3	B	403	2PK	CAD-CAL	-6.07	1.41	1.51
3	A	403	2PK	CAD-CAL	-6.01	1.41	1.51
3	B	403	2PK	CAO-CAN	-5.13	1.35	1.48
3	A	403	2PK	CAO-CAN	-5.02	1.35	1.48

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	403	2PK	CAL-CAD-CAO	6.69	128.96	113.46
3	A	403	2PK	CAL-CAD-CAO	6.39	128.26	113.46
3	A	403	2PK	CAD-CAO-CAN	5.66	134.72	122.28
3	B	403	2PK	CAD-CAO-CAN	5.32	133.95	122.28
3	B	403	2PK	CAD-CAL-CAH	4.55	127.74	120.88
3	A	403	2PK	OAB-CAN-NAI	-4.41	118.08	124.80
3	A	403	2PK	CAD-CAL-CAH	4.25	127.28	120.88
3	B	403	2PK	CAD-CAL-CAG	-3.96	114.92	120.88
3	B	403	2PK	OAB-CAN-NAI	-3.54	119.40	124.80
3	A	403	2PK	CAD-CAL-CAG	-3.53	115.56	120.88

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	403	2PK	CAN-CAO-CAD-CAL
3	A	403	2PK	CAN-CAO-CAD-CAL

There are no ring outliers.

## 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	331/336 (98%)	0.43	23 (6%) 17 18	30, 48, 134, 201	0
1	B	321/336 (95%)	0.77	37 (11%) 5 6	31, 58, 152, 215	0
All	All	652/672 (97%)	0.60	60 (9%) 9 10	30, 52, 141, 215	0

All (60) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	190	ALA	21.9
1	B	189	TYR	18.2
1	B	191	GLY	13.8
1	A	192	ILE	10.9
1	A	143	SER	10.6
1	A	190	ALA	10.2
1	B	192	ILE	9.4
1	B	145	ALA	9.3
1	A	191	GLY	9.2
1	B	146	LEU	8.1
1	A	195	GLY	7.2
1	B	257	GLY	6.8
1	A	189	TYR	6.7
1	A	-6	ILE	6.3
1	B	313	LEU	6.2
1	B	196	ARG	6.0
1	B	193	GLU	5.7
1	A	145	ALA	5.5
1	B	194	GLN	5.4
1	B	148	LYS	5.3
1	B	195	GLY	5.1
1	B	316	GLU	4.9
1	B	312	ASP	4.9
1	B	141	ASP	4.8

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Mol	Chain	Res	Type	RSRZ
1	B	143	SER	4.5
1	B	139	TYR	4.5
1	A	144	GLU	4.3
1	B	188	GLY	4.1
1	B	95	ASP	4.1
1	A	94	HIS	4.0
1	A	96	TRP	3.9
1	B	314	MET	3.8
1	B	153	PHE	3.6
1	A	97	LYS	3.6
1	A	193	GLU	3.5
1	B	144	GLU	3.4
1	B	142	GLU	3.2
1	B	259	PRO	3.2
1	A	146	LEU	3.1
1	A	257	GLY	3.1
1	A	95	ASP	3.1
1	A	147	ARG	3.1
1	B	315	GLY	3.1
1	B	186	LEU	3.0
1	A	194	GLN	3.0
1	B	149	ASN	2.9
1	B	156	PHE	2.9
1	A	256	ARG	2.9
1	B	317	ILE	2.7
1	B	256	ARG	2.7
1	A	188	GLY	2.6
1	B	258	GLU	2.5
1	B	187	ALA	2.4
1	B	96	TRP	2.4
1	A	56	THR	2.3
1	B	147	ARG	2.3
1	A	215	GLY	2.1
1	B	94	HIS	2.1
1	B	280	ILE	2.1
1	A	187	ALA	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

There are no carbohydrates in this entry.

### 6.4 Ligands

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	RSR	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
3	2PK	B	403	15/15	0.56	9.12	35,52,74,226	15
2	MN	B	402	1/1	0.23	7.68	64,64,64,64	1
3	2PK	A	403	15/15	0.68	6.18	36,58,83,196	15
2	MN	A	402	1/1	0.13	-0.22	52,52,52,52	1
2	MN	B	401	1/1	0.11	-2.38	69,69,69,69	1
2	MN	A	401	1/1	0.05	-2.93	63,63,63,63	1

### 6.5 Other polymers

There are no such residues in this entry.