



# Full wwPDB X-ray Structure Validation Report ⓘ

Feb 1, 2016 – 06:41 PM GMT

PDB ID : 4MGK  
Title : Selective activation of Epac1 and Epac2  
Authors : Rehmann, H.  
Deposited on : 2013-08-28  
Resolution : 2.70 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  
<http://wwpdb.org/validation/2016/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 : 1.7 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Refmac : 5.8.0135  
CCP4 : 6.5.0  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : trunk26865

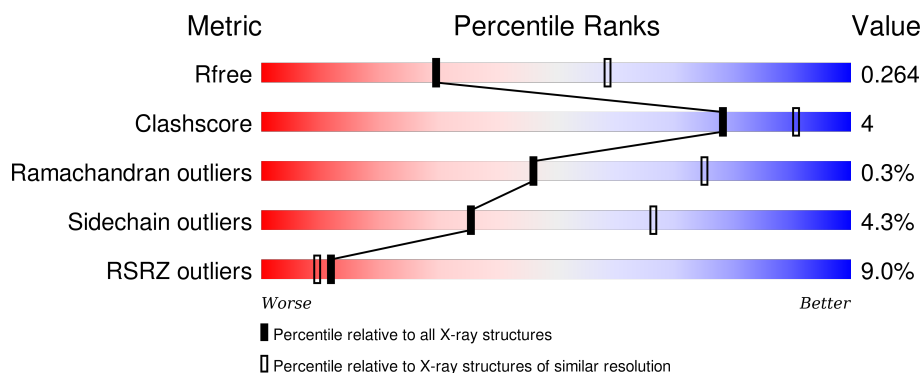
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 2.70 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))
$R_{free}$	91344	2103 (2.70-2.70)
Clashscore	102246	2422 (2.70-2.70)
Ramachandran outliers	100387	2382 (2.70-2.70)
Sidechain outliers	100360	2382 (2.70-2.70)
RSRZ outliers	91569	2107 (2.70-2.70)

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. 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	E	694	
2	R	167	

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 6402 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 Rap guanine nucleotide exchange factor 4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	E	627	Total	C	N	O	S	0	0	0
			5052	3221	871	929	31			

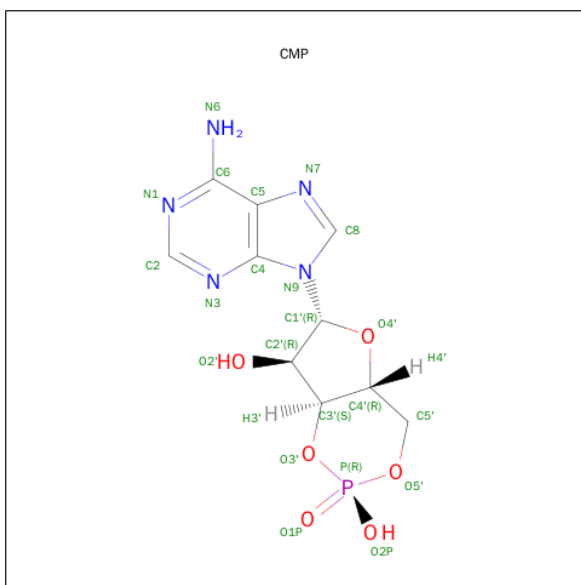
There are 7 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
E	300	GLY	-	EXPRESSION TAG	UNP Q9EQZ6
E	301	SER	-	EXPRESSION TAG	UNP Q9EQZ6
E	302	PRO	-	EXPRESSION TAG	UNP Q9EQZ6
E	303	GLU	-	EXPRESSION TAG	UNP Q9EQZ6
E	304	SER	-	EXPRESSION TAG	UNP Q9EQZ6
E	305	PHE	-	EXPRESSION TAG	UNP Q9EQZ6
E	405	GLN	LYS	ENGINEERED MUTATION	UNP Q9EQZ6

- Molecule 2 is a protein called Ras-related protein Rap-1b.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	R	150	Total	C	N	O	S	0	0	0
			1186	748	196	236	6			

- Molecule 3 is ADENOSINE-3',5'-CYCLIC-MONOPHOSPHATE (three-letter code: CMP) (formula: C<sub>10</sub>H<sub>12</sub>N<sub>5</sub>O<sub>6</sub>P).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	E	1	Total	C	N	O	P	0	0
			22	10	5	6	1		

- Molecule 4 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	R	1	Total	O S	0	0
			5	4 1		

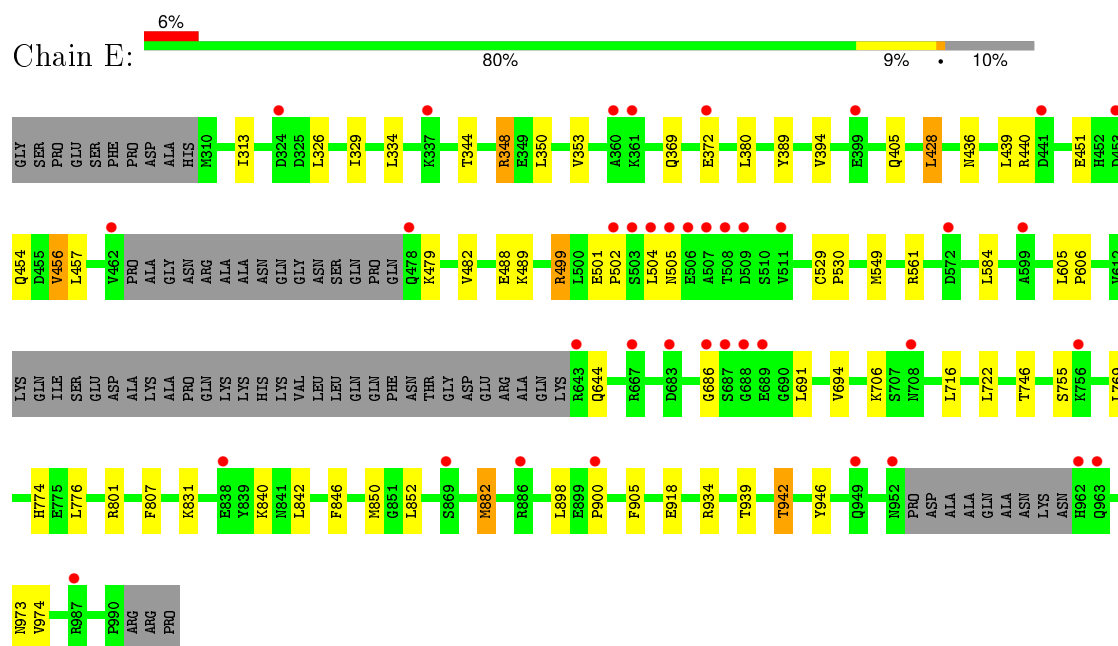
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	E	121	Total 121	O 121	0	0
5	R	16	Total 16	O 16	0	0

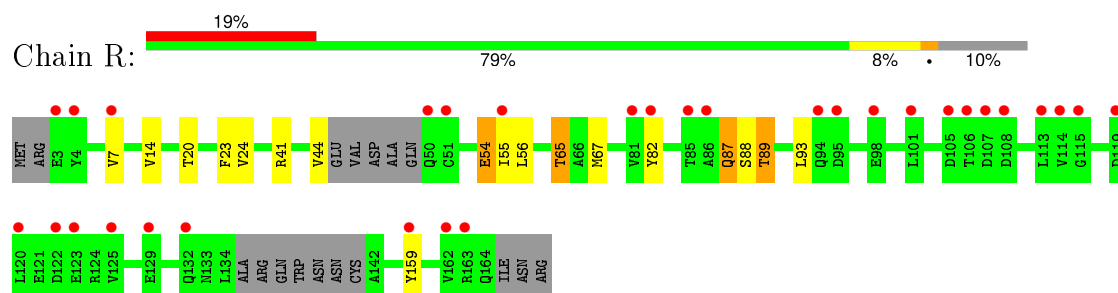
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of 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: Rap guanine nucleotide exchange factor 4



- Molecule 2: Ras-related protein Rap-1b



## 4 Data and refinement statistics

Property	Value	Source
Space group	I 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	125.04Å 144.55Å 227.84Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.90 – 2.70 19.91 – 2.70	Depositor EDS
% Data completeness (in resolution range)	100.0 (19.90-2.70) 99.6 (19.91-2.70)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.07 (at 2.71Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, $R_{free}$	0.249 , 0.264 0.249 , 0.264	Depositor DCC
$R_{free}$ test set	2737 reflections (5.09%)	DCC
Wilson B-factor (Å <sup>2</sup> )	49.2	Xtriage
Anisotropy	0.310	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.36 , 46.9	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	0 of 56554 reflections	Xtriage
$F_o, F_c$ correlation	0.90	EDS
Total number of atoms	6402	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	53.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.08% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: SO4, CMP

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	E	0.33	0/5152	0.49	0/6964
2	R	0.34	0/1198	0.51	0/1610
All	All	0.33	0/6350	0.49	0/8574

There are no bond length outliers.

There are no bond angle outliers.

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	E	5052	0	5076	34	0
2	R	1186	0	1180	13	0
3	E	22	0	11	1	0
4	R	5	0	0	0	0
5	E	121	0	0	2	0
5	R	16	0	0	0	0
All	All	6402	0	6267	45	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 (45) 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)
3:E:1001:CMP:C2	3:E:1001:CMP:H2	0.97	1.47
2:R:14:VAL:HG21	2:R:89:THR:HG21	1.51	0.91
2:R:14:VAL:CG2	2:R:89:THR:HG21	2.13	0.79
1:E:905:PHE:CZ	2:R:67:MET:HE1	2.20	0.75
1:E:369:GLN:HE22	1:E:389:TYR:H	1.41	0.69
1:E:394:VAL:HG13	1:E:451:GLU:HG2	1.77	0.67
1:E:905:PHE:HZ	2:R:67:MET:HE1	1.66	0.59
1:E:716:LEU:HD11	1:E:722:LEU:HD13	1.83	0.58
1:E:774:HIS:HD2	1:E:776:LEU:H	1.51	0.57
1:E:482:VAL:O	1:E:934:ARG:NH2	2.41	0.53
1:E:807:PHE:HB3	1:E:974:VAL:HG13	1.88	0.53
1:E:451:GLU:HG3	1:E:456:VAL:HG11	1.91	0.53
2:R:23:PHE:CD2	2:R:55:ILE:HD11	2.44	0.53
1:E:846:PHE:HD2	1:E:882:MET:HE3	1.74	0.52
1:E:456:VAL:HG13	1:E:489:LYS:HG2	1.91	0.52
1:E:499:ARG:HG2	1:E:504:LEU:HD13	1.92	0.51
2:R:82:TYR:HB3	2:R:93:LEU:HD11	1.93	0.51
2:R:20:THR:O	2:R:24:VAL:HG22	2.13	0.49
1:E:850:MET:HG3	1:E:882:MET:HE1	1.95	0.48
2:R:44:VAL:HG11	2:R:159:TYR:HE2	1.79	0.48
1:E:842:LEU:O	1:E:846:PHE:HD1	1.97	0.48
2:R:7:VAL:HG22	2:R:56:LEU:HB2	1.98	0.46
1:E:394:VAL:CG1	1:E:451:GLU:HG2	2.45	0.46
1:E:905:PHE:HZ	2:R:67:MET:CE	2.28	0.45
1:E:840:LYS:HG2	1:E:898:LEU:HD22	1.99	0.45
2:R:87:GLN:CD	2:R:87:GLN:H	2.21	0.44
1:E:939:THR:O	1:E:942:THR:HB	2.17	0.44
1:E:501:GLU:HA	1:E:502:PRO:HD3	1.84	0.44
1:E:436:ASN:HA	1:E:440:ARG:HB2	1.98	0.44
1:E:457:LEU:HB2	1:E:489:LYS:HG2	1.99	0.43
2:R:41:ARG:HG2	2:R:54:GLU:HG2	1.99	0.43
1:E:380:LEU:HD11	1:E:428:LEU:HD13	1.99	0.43
1:E:313:ILE:HG22	1:E:329:ILE:HD11	2.01	0.43
1:E:846:PHE:CD2	1:E:882:MET:HE3	2.53	0.43
1:E:605:LEU:N	1:E:606:PRO:HD2	2.34	0.43
1:E:846:PHE:HD2	1:E:882:MET:CE	2.31	0.42
1:E:350:LEU:HD11	1:E:439:LEU:HD21	2.01	0.42
1:E:344:THR:O	1:E:348:ARG:HG2	2.18	0.42
1:E:549:MET:HG2	5:E:1174:HOH:O	2.20	0.42
1:E:369:GLN:HB3	1:E:389:TYR:CZ	2.54	0.42
1:E:529:CYS:HB2	1:E:530:PRO:HD3	2.02	0.42

*Continued on next page...*

*Continued from previous page...*

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:E:755:SER:OG	1:E:831:LYS:HB3	2.20	0.41
1:E:505:ASN:HA	1:E:561:ARG:HH22	1.85	0.41
5:E:1114:HOH:O	2:R:65:THR:HG21	2.21	0.40
1:E:942:THR:HG23	1:E:946:TYR:CE1	2.55	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	E	619/694 (89%)	605 (98%)	12 (2%)	2 (0%)	46	75
2	R	144/167 (86%)	133 (92%)	11 (8%)	0	100	100
All	All	763/861 (89%)	738 (97%)	23 (3%)	2 (0%)	46	75

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	E	686	GLY
1	E	900	PRO

### 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.

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	E	562/615 (91%)	537 (96%)	25 (4%)	35	65
2	R	132/147 (90%)	127 (96%)	5 (4%)	40	71
All	All	694/762 (91%)	664 (96%)	30 (4%)	35	66

All (30) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	326	LEU
1	E	334	LEU
1	E	348	ARG
1	E	353	VAL
1	E	372	GLU
1	E	405	GLN
1	E	428	LEU
1	E	454	GLN
1	E	456	VAL
1	E	479	LYS
1	E	488	GLU
1	E	499	ARG
1	E	584	LEU
1	E	644	GLN
1	E	691	LEU
1	E	694	VAL
1	E	706	LYS
1	E	746	THR
1	E	769	LEU
1	E	801	ARG
1	E	852	LEU
1	E	882	MET
1	E	918	GLU
1	E	942	THR
1	E	973	ASN
2	R	54	GLU
2	R	65	THR
2	R	87	GLN
2	R	88	SER
2	R	89	THR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	E	369	GLN
1	E	405	GLN
1	E	426	HIS
1	E	436	ASN
1	E	535	HIS
1	E	539	GLN
1	E	542	GLN
1	E	917	HIS
1	E	983	GLN
1	E	986	HIS
2	R	50	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](#)

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](#)

2 ligands 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	$\# Z  > 2$
3	CMP	E	1001	-	19,25,25	1.35	3 (15%)	18,39,39	2.48	4 (22%)
4	SO4	R	201	-	4,4,4	0.19	0	6,6,6	0.25	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
3	CMP	E	1001	-	-	0/0/31/31	0/4/4/4
4	SO4	R	201	-	-	0/0/0/0	0/0/0/0

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	E	1001	CMP	O4'-C1'	2.22	1.44	1.41
3	E	1001	CMP	P-O3'	2.32	1.62	1.58
3	E	1001	CMP	C5-C4	3.34	1.48	1.40

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	E	1001	CMP	N3-C2-N1	-7.42	123.21	128.89
3	E	1001	CMP	O3'-C3'-C4'	-4.32	107.27	110.72
3	E	1001	CMP	C4-C5-N7	-2.95	106.77	109.48
3	E	1001	CMP	O2P-P-O1P	3.09	118.65	108.80

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	E	1001	CMP	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	E	627/694 (90%)	0.31	39 (6%) 24 23	34, 48, 67, 77	0
2	R	150/167 (89%)	1.02	31 (20%) 1 1	45, 68, 91, 93	0
All	All	777/861 (90%)	0.44	70 (9%) 12 9	34, 50, 79, 93	0

All (70) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	503	SER	8.9
1	E	507	ALA	8.1
1	E	504	LEU	7.9
1	E	502	PRO	7.9
1	E	506	GLU	6.6
1	E	462	VAL	5.8
2	R	108	ASP	5.4
1	E	900	PRO	5.2
2	R	125	VAL	5.1
2	R	105	ASP	4.8
2	R	107	ASP	4.6
2	R	51	CYS	4.3
1	E	508	THR	4.3
1	E	688	GLY	4.2
2	R	123	GLU	4.1
2	R	114	VAL	3.7
1	E	869	SER	3.6
1	E	337	LYS	3.6
1	E	963	GLN	3.5
1	E	683	ASP	3.5
2	R	106	THR	3.5
2	R	122	ASP	3.4
2	R	115	GLY	3.3
1	E	505	ASN	3.3

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
1	E	689	GLU	3.3
1	E	952	ASN	3.1
2	R	101	LEU	3.1
2	R	55	ILE	3.1
1	E	949	GLN	3.0
2	R	132	GLN	3.0
2	R	3	GLU	2.9
1	E	962	HIS	2.8
2	R	50	GLN	2.8
2	R	86	ALA	2.8
1	E	441	ASP	2.8
2	R	4	TYR	2.8
2	R	129	GLU	2.8
1	E	987	ARG	2.7
1	E	399	GLU	2.7
1	E	687	SER	2.6
1	E	453	ASP	2.5
1	E	572	ASP	2.5
1	E	478	GLN	2.5
2	R	162	VAL	2.4
2	R	94	GLN	2.4
1	E	838	GLU	2.4
1	E	509	ASP	2.4
2	R	113	LEU	2.3
2	R	120	LEU	2.3
2	R	81	VAL	2.3
2	R	7	VAL	2.3
1	E	756	LYS	2.3
2	R	159	TYR	2.3
1	E	361	LYS	2.2
1	E	643	ARG	2.2
1	E	708	ASN	2.2
1	E	511	VAL	2.2
2	R	82	TYR	2.2
1	E	360	ALA	2.2
1	E	686	GLY	2.2
2	R	85	THR	2.2
2	R	98	GLU	2.2
1	E	324	ASP	2.2
1	E	372	GLU	2.1
1	E	667	ARG	2.1
1	E	599	ALA	2.1

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
2	R	119	ASP	2.1
2	R	163	ARG	2.1
2	R	95	ASP	2.0
1	E	886	ARG	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. 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	RSCC	RSR	LLDF	B-factors( $\text{\AA}^2$ )	Q<0.9
3	CMP	E	1001	22/22	0.98	0.13	-0.99	30,31,32,32	0
4	SO4	R	201	5/5	0.97	0.09	-1.72	43,43,43,44	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.