



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 27, 2024 – 09:26 PM EDT

PDB ID : 2BDU  
Title : X-Ray Structure of a Cytosolic 5'-Nucleotidase III from Mus Musculus MM.158936  
Authors : Wesenberg, G.E.; Phillips Jr., G.N.; Han, B.W.; Bitto, E.; Bingman, C.A.; Bae, E.; Center for Eukaryotic Structural Genomics (CESG)  
Deposited on : 2005-10-20  
Resolution : 2.35 Å(reported)

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<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 : 2022.3.0, CSD as543be (2022)  
Xtriage (Phenix) : 1.20.1  
EDS : 3.0  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
CCP4 : 9.0.003 (Gargrove)  
Density-Fitness : 1.0.11  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.39

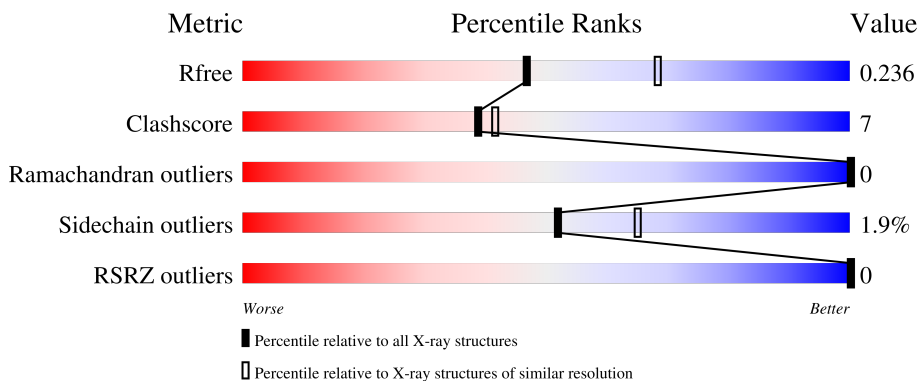
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.35 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))
$R_{free}$	164625	1460 (2.36-2.36)
Clashscore	180529	1571 (2.36-2.36)
Ramachandran outliers	177936	1559 (2.36-2.36)
Sidechain outliers	177891	1559 (2.36-2.36)
RSRZ outliers	164620	1460 (2.36-2.36)

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	297	 82% 15%
1	B	297	 81% 16%

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 5049 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 Cytosolic 5'-nucleotidase III.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	N	O	S	Se			
1	A	291	2330	1489	388	440	5	8	0	1	0
1	B	291	2330	1489	388	440	5	8	0	1	0

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	SER	-	cloning artifact	UNP Q9D020
A	12	MSE	MET	modified residue	UNP Q9D020
A	13	MSE	MET	modified residue	UNP Q9D020
A	52	MSE	MET	modified residue	UNP Q9D020
A	110	MSE	MET	modified residue	UNP Q9D020
A	141	MSE	MET	modified residue	UNP Q9D020
A	192	MSE	MET	modified residue	UNP Q9D020
A	245	MSE	MET	modified residue	UNP Q9D020
A	273	MSE	MET	modified residue	UNP Q9D020
B	1	SER	-	cloning artifact	UNP Q9D020
B	12	MSE	MET	modified residue	UNP Q9D020
B	13	MSE	MET	modified residue	UNP Q9D020
B	52	MSE	MET	modified residue	UNP Q9D020
B	110	MSE	MET	modified residue	UNP Q9D020
B	141	MSE	MET	modified residue	UNP Q9D020
B	192	MSE	MET	modified residue	UNP Q9D020
B	245	MSE	MET	modified residue	UNP Q9D020
B	273	MSE	MET	modified residue	UNP Q9D020

- Molecule 2 is 4-(2-HYDROXYETHYL)-1-PIPERAZINE ETHANESULFONIC ACID (three-letter code: EPE) (formula: C<sub>8</sub>H<sub>18</sub>N<sub>2</sub>O<sub>4</sub>S).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	S		
2	A	1	15	8	2	4	1	0	0
2	B	1	15	8	2	4	1	0	0

- Molecule 3 is water.

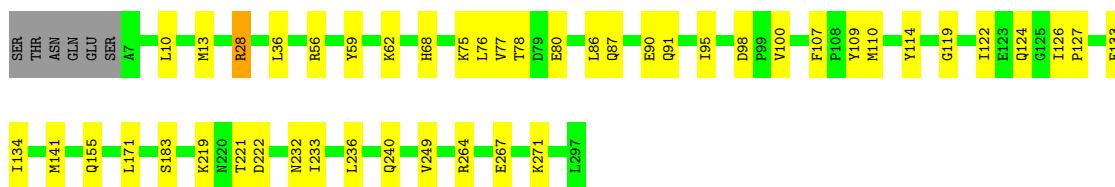
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	180	180	180	0	0
3	B	179	179	179	0	0

### 3 Residue-property plots


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.

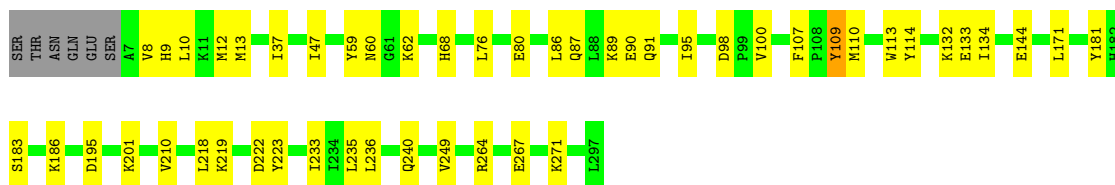
- Molecule 1: Cytosolic 5'-nucleotidase III

Chain A: 



- Molecule 1: Cytosolic 5'-nucleotidase III

Chain B: 



## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 32	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	133.67Å 133.67Å 38.89Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	43.76 – 2.35 43.76 – 2.35	Depositor EDS
% Data completeness (in resolution range)	98.5 (43.76-2.35) 98.5 (43.76-2.35)	Depositor EDS
$R_{merge}$	0.09	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.92 (at 2.34Å)	Xtrriage
Refinement program	REFMAC refmac_5.2.0005	Depositor
R, $R_{free}$	0.163 , 0.220 0.176 , 0.236	Depositor DCC
$R_{free}$ test set	1619 reflections (4.95%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	42.1	Xtrriage
Anisotropy	0.145	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 28.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.480 for -h,-k,l 0.036 for h,-h-k,-l 0.035 for -k,-h,-l	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	5049	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	48.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.27% 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: EPE

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	0.86	2/2366 (0.1%)	0.76	0/3172
1	B	0.84	2/2366 (0.1%)	0.74	0/3172
All	All	0.85	4/4732 (0.1%)	0.75	0/6344

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	80	GLU	CD-OE1	10.01	1.36	1.25
1	A	80	GLU	CD-OE2	9.44	1.36	1.25
1	B	80	GLU	CD-OE1	5.47	1.31	1.25
1	B	109	TYR	CG-CD2	5.17	1.45	1.39

There are no bond angle outliers.

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	2330	0	2350	35	0
1	B	2330	0	2350	30	0
2	A	15	0	17	0	0
2	B	15	0	17	0	0
3	A	180	0	0	12	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	179	0	0	5	0
All	All	5049	0	4734	63	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 7.

All (63) 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:B:133:GLU:HG3	3:B:464:HOH:O	1.78	0.81
1:A:133:GLU:HG3	3:A:465:HOH:O	1.84	0.76
1:B:10:LEU:HA	1:B:13:MSE:HE3	1.70	0.73
1:A:10:LEU:HD23	1:A:13:MSE:HE3	1.73	0.70
1:B:10:LEU:HD23	1:B:13:MSE:CE	2.22	0.69
1:B:10:LEU:HD23	1:B:13:MSE:HE1	1.76	0.66
1:B:264:ARG:NH1	1:B:267:GLU:OE2	2.31	0.63
1:B:219:LYS:HE3	3:B:467:HOH:O	1.98	0.61
1:A:68:HIS:HD2	3:A:445:HOH:O	1.83	0.61
1:B:110:MSE:HE3	1:B:114:TYR:HE1	1.64	0.61
1:B:76:LEU:HD12	1:B:134:ILE:HD11	1.82	0.61
1:A:86:LEU:O	1:A:90:GLU:HG2	2.01	0.60
1:B:110:MSE:HE2	1:B:210:VAL:HG12	1.83	0.60
1:A:219:LYS:HE3	3:A:472:HOH:O	2.02	0.59
1:A:75:LYS:HE3	3:A:525:HOH:O	2.01	0.59
1:A:10:LEU:HD23	1:A:13:MSE:CE	2.33	0.58
1:B:59:TYR:O	1:B:62:LYS:N	2.30	0.57
1:A:141:MSE:HE2	3:A:560:HOH:O	2.04	0.56
1:A:141:MSE:HG3	3:A:560:HOH:O	2.05	0.56
1:B:10:LEU:HA	1:B:13:MSE:CE	2.36	0.56
1:A:10:LEU:HA	1:A:13:MSE:HE3	1.88	0.56
1:B:60:ASN:ND2	3:B:457:HOH:O	2.38	0.56
1:B:195:ASP:HB3	1:B:201:LYS:HD3	1.87	0.56
1:A:28:ARG:HG2	3:A:441:HOH:O	2.04	0.56
1:A:87:GLN:O	1:A:91:GLN:HG3	2.06	0.56
1:A:264:ARG:NH1	1:A:267:GLU:OE2	2.39	0.56
1:A:76:LEU:HD12	1:A:134:ILE:HD11	1.87	0.55
1:A:59:TYR:CG	3:A:560:HOH:O	2.62	0.53
1:A:110:MSE:HE3	1:A:114:TYR:HE1	1.73	0.53
1:A:98:ASP:OD1	1:A:100:VAL:HG12	2.09	0.53
1:B:171:LEU:HD23	1:B:171:LEU:C	2.30	0.52
1:B:233:ILE:HD11	1:B:249:VAL:HG11	1.91	0.52

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:59:TYR:O	1:A:62:LYS:N	2.32	0.51
1:B:68:HIS:HD2	3:B:475:HOH:O	1.93	0.51
1:B:87:GLN:O	1:B:91:GLN:HG3	2.10	0.51
1:A:77:VAL:HG22	1:A:124:GLN:HG3	1.91	0.51
1:B:86:LEU:O	1:B:90:GLU:HG3	2.12	0.49
1:A:233:ILE:HD11	1:A:249:VAL:HG11	1.94	0.48
1:A:240:GLN:OE1	1:A:271:LYS:HE3	2.13	0.48
1:A:141:MSE:CG	3:A:560:HOH:O	2.61	0.48
1:B:89:LYS:HG3	1:B:113:TRP:HZ2	1.79	0.48
1:A:28:ARG:HD3	3:A:473:HOH:O	2.15	0.46
1:B:95:ILE:HG21	1:B:109:TYR:CG	2.51	0.45
1:A:171:LEU:C	1:A:171:LEU:HD23	2.36	0.45
1:A:110:MSE:CE	1:A:114:TYR:HE1	2.29	0.45
1:B:8:VAL:HG22	1:B:37:ILE:HD12	1.98	0.44
1:A:126:ILE:HA	1:A:127:PRO:HD3	1.89	0.43
1:A:119:GLY:HA2	1:A:122:ILE:HD12	2.01	0.43
1:A:95:ILE:HG21	1:A:109:TYR:CG	2.53	0.43
1:A:56:ARG:HD2	3:A:560:HOH:O	2.18	0.43
1:B:144:GLU:HG2	3:B:432:HOH:O	2.18	0.43
1:B:47:ILE:O	1:B:235:LEU:HA	2.19	0.43
1:B:98:ASP:OD1	1:B:100:VAL:HG22	2.19	0.42
1:A:36:LEU:HD23	1:A:232:ASN:HB3	2.02	0.42
1:A:78:THR:HG23	1:A:124:GLN:OE1	2.19	0.42
1:B:9:HIS:CD2	1:B:12:MSE:HE2	2.55	0.41
1:A:183:SER:HA	1:B:183:SER:HA	2.02	0.41
1:A:62:LYS:HD2	3:A:567:HOH:O	2.20	0.41
1:B:110:MSE:CE	1:B:114:TYR:HE1	2.32	0.41
1:B:240:GLN:OE1	1:B:271:LYS:HE3	2.21	0.41
1:A:95:ILE:HG21	1:A:109:TYR:CD2	2.56	0.40
1:A:155:GLN:HG2	1:B:132:LYS:NZ	2.36	0.40
1:B:186:LYS:HD2	1:B:223:TYR:CD1	2.56	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	A	290/297 (98%)	280 (97%)	10 (3%)	0	100	100
1	B	290/297 (98%)	279 (96%)	11 (4%)	0	100	100
All	All	580/594 (98%)	559 (96%)	21 (4%)	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	261/258 (101%)	256 (98%)	5 (2%)	52	65
1	B	261/258 (101%)	256 (98%)	5 (2%)	52	65
All	All	522/516 (101%)	512 (98%)	10 (2%)	52	65

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	28	ARG
1	A	107	PHE
1	A	221	THR
1	A	222	ASP
1	A	236	LEU
1	B	107	PHE
1	B	181	TYR
1	B	218	LEU
1	B	222	ASP
1	B	236	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	9	HIS
1	B	60	ASN

### 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 oligosaccharides 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
2	EPE	B	402	-	15,15,15	0.87	1 (6%)	19,20,20	1.95	5 (26%)
2	EPE	A	401	-	15,15,15	0.90	1 (6%)	19,20,20	1.78	4 (21%)

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
2	EPE	B	402	-	-	1/9/19/19	0/1/1/1
2	EPE	A	401	-	-	4/9/19/19	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	401	EPE	C10-S	3.05	1.81	1.77
2	B	402	EPE	C10-S	3.01	1.81	1.77

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	402	EPE	C5-N4-C3	5.09	119.80	108.84
2	A	401	EPE	C5-N4-C3	4.50	118.54	108.84
2	B	402	EPE	O2S-S-O1S	-2.79	104.76	113.82
2	A	401	EPE	C7-N4-C3	2.63	118.25	111.24
2	A	401	EPE	O3S-S-C10	2.61	111.12	106.00
2	A	401	EPE	C6-C5-N4	2.57	115.84	110.65
2	B	402	EPE	C6-C5-N4	2.57	115.83	110.65
2	B	402	EPE	O2S-S-C10	2.44	110.42	106.73
2	B	402	EPE	C2-C3-N4	2.02	114.73	110.65

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	401	EPE	C9-C10-S-O3S
2	A	401	EPE	N4-C7-C8-O8
2	B	402	EPE	C8-C7-N4-C5
2	A	401	EPE	C9-C10-S-O1S
2	A	401	EPE	C9-C10-S-O2S

There are no ring outliers.

No monomer is involved in short contacts.

## 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	283/297 (95%)	-1.58	0 <a href="#">100</a> <a href="#">100</a>	35, 46, 58, 68	1 (0%)
1	B	283/297 (95%)	-1.60	0 <a href="#">100</a> <a href="#">100</a>	35, 46, 58, 67	1 (0%)
All	All	566/594 (95%)	-1.59	0 <a href="#">100</a> <a href="#">100</a>	35, 46, 58, 68	2 (0%)

There are no RSRZ outliers to report.

### 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 monosaccharides 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
2	EPE	A	401	15/15	0.99	0.03	58,66,80,80	0
2	EPE	B	402	15/15	0.99	0.03	59,67,74,81	0

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

There are no such residues in this entry.