



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 07:07 PM UTC

PDB ID : 3TK2 / pdb\_00003tk2  
Title : Crystallographic structure of phenylalanine hydroxylase from *Chromobacterium violaceum* cocrystallized with phenylalanine in a site distal to the active site  
Authors : Ronau, J.A.; Abu-Omar, M.M.; Das, C.  
Deposited on : 2011-08-25  
Resolution : 1.35 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 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 : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtriage (Phenix) : 2.0  
EDS : 3.0  
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)  
CCP4 : 9.0.010 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.49

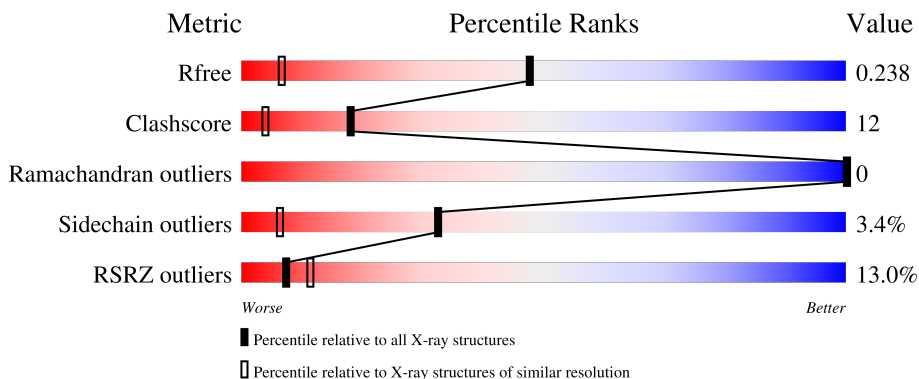
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.35 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))
$R_{free}$	180053	1216 (1.36-1.36)
Clashscore	190562	1232 (1.36-1.36)
Ramachandran outliers	187476	1220 (1.36-1.36)
Sidechain outliers	187428	1220 (1.36-1.36)
RSRZ outliers	180081	1214 (1.36-1.36)

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	302	

## 2 Entry composition i

There are 4 unique types of molecules in this entry. The entry contains 2556 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.

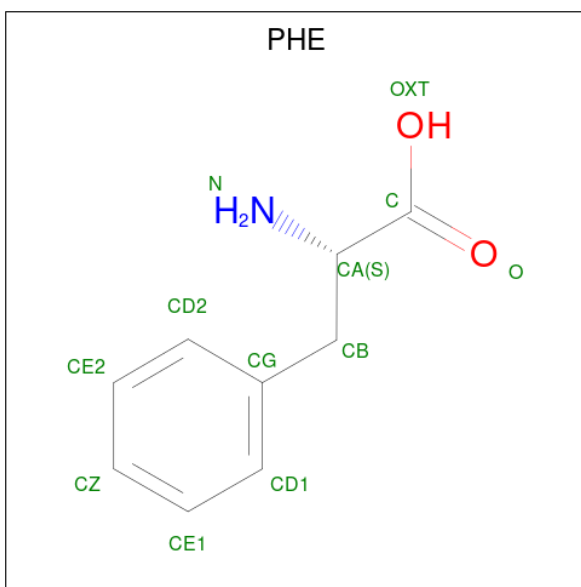
- Molecule 1 is a protein called Phenylalanine-4-hydroxylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	277	2259	1467	374	408	10	0	6	0

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-4	GLY	-	expression tag	UNP P30967
A	-3	PRO	-	expression tag	UNP P30967
A	-2	LEU	-	expression tag	UNP P30967
A	-1	GLY	-	expression tag	UNP P30967
A	0	SER	-	expression tag	UNP P30967

- Molecule 2 is PHENYLALANINE (CCD ID: PHE) (formula: C<sub>9</sub>H<sub>11</sub>NO<sub>2</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
2	A	1	12	9	1	2	0	0

- Molecule 3 is COBALT (II) ION (CCD ID: CO) (formula: Co).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	2	Total 2	Co 2	0	0

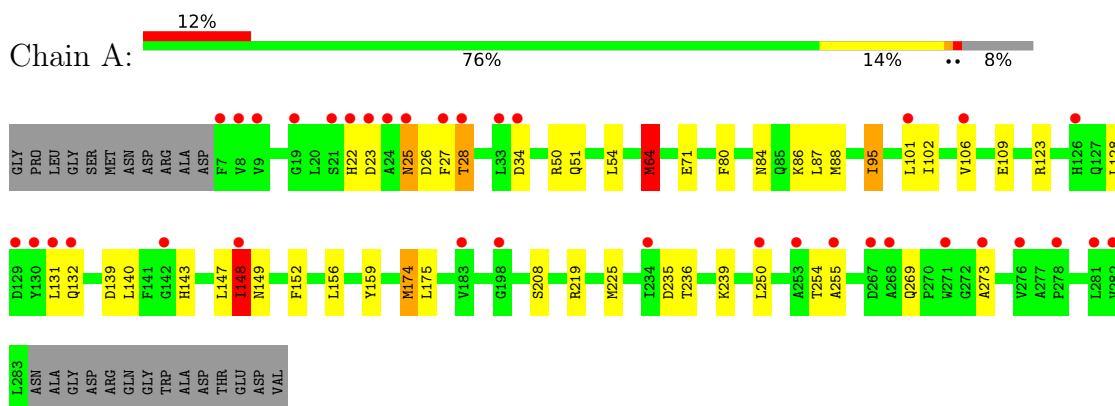
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	283	Total 283	O 283	0	0

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

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: Phenylalanine-4-hydroxylase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	36.93Å 38.56Å 47.80Å 76.56° 72.90° 85.41°	Depositor
Resolution (Å)	24.49 – 1.35 24.49 – 1.35	Depositor EDS
% Data completeness (in resolution range)	93.8 (24.49-1.35) 93.7 (24.49-1.35)	Depositor EDS
$R_{merge}$	0.04	Depositor
$R_{sym}$	0.04	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	4.46 (at 1.35Å)	Xtrriage
Refinement program	REFMAC 5.5.0110	Depositor
R, $R_{free}$	0.159 , 0.207 0.199 , 0.238	Depositor DCC
$R_{free}$ test set	2557 reflections (4.76%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	15.1	Xtrriage
Anisotropy	0.131	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.40 , 44.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	2556	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	15.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.25% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section:  
CO

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	1.34	7/2330 (0.3%)	1.23	9/3177 (0.3%)

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	174	MET	CB-CG	14.95	1.97	1.52
1	A	255	ALA	CA-C	7.45	1.62	1.52
1	A	250	LEU	CA-C	-6.35	1.44	1.52
1	A	254	THR	CA-CB	5.69	1.61	1.53
1	A	219	ARG	CZ-NH2	-5.33	1.26	1.33
1	A	87	LEU	C-O	5.10	1.30	1.24
1	A	225	MET	CB-CG	-5.09	1.37	1.52

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	64	MET	CG-SD-CE	9.74	122.33	100.90
1	A	174	MET	CB-CG-SD	-7.33	90.69	112.70
1	A	174	MET	CG-SD-CE	-7.14	85.20	100.90
1	A	34	ASP	N-CA-C	-6.64	105.15	113.18
1	A	219	ARG	NE-CZ-NH2	-6.04	113.77	119.20
1	A	174	MET	CB-CA-C	5.67	120.48	110.85
1	A	148	ILE	N-CA-C	-5.40	105.73	113.07
1	A	250	LEU	N-CA-CB	5.14	117.59	109.94
1	A	25	ASN	N-CA-C	5.11	119.38	111.56

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	A	2259	0	2216	55	1
2	A	12	0	8	0	0
3	A	2	0	0	0	0
4	A	283	0	0	18	3
All	All	2556	0	2224	55	3

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 12.

All (55) 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:A:174:MET:CB	1:A:174:MET:CG	1.97	1.39
1:A:22:HIS:NE2	4:A:333:HOH:O	1.58	1.35
1:A:88[A]:MET:HE1	4:A:314:HOH:O	1.41	1.20
1:A:109:GLU:HG2	4:A:533:HOH:O	1.46	1.14
1:A:22:HIS:CE1	4:A:333:HOH:O	1.95	1.03
1:A:23:ASP:HB3	1:A:27:PHE:H	1.37	0.89
1:A:80:PHE:CD1	1:A:95[A]:ILE:HD11	2.12	0.85
1:A:174:MET:CB	1:A:174:MET:SD	2.65	0.85
1:A:80:PHE:CG	1:A:95[A]:ILE:HD11	2.12	0.85
1:A:71:GLU:OE2	1:A:86:LYS:HE2	1.86	0.75
1:A:149:ASN:HD22	1:A:152:PHE:H	1.38	0.70
1:A:50:ARG:HE	1:A:51:GLN:HE21	1.39	0.69
1:A:102[B]:ILE:CD1	1:A:102[B]:ILE:H	2.05	0.69
1:A:102[B]:ILE:H	1:A:102[B]:ILE:HD13	1.57	0.68
1:A:84:ASN:HB3	1:A:88[B]:MET:HE2	1.76	0.68
1:A:23:ASP:HB3	1:A:27:PHE:N	2.07	0.68
1:A:23:ASP:OD1	1:A:25:ASN:HB2	1.99	0.61
1:A:54:LEU:HD23	4:A:532:HOH:O	2.00	0.61
1:A:80:PHE:CD1	1:A:95[A]:ILE:CD1	2.82	0.61
1:A:236:THR:CG2	4:A:549:HOH:O	2.47	0.61
1:A:26:ASP:OD1	1:A:28[A]:THR:HB	2.01	0.60
1:A:147:LEU:CD2	1:A:156:LEU:HD12	2.31	0.59
1:A:132:GLN:HG3	4:A:530:HOH:O	2.02	0.58

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:50:ARG:HE	1:A:51:GLN:NE2	2.00	0.58
1:A:236:THR:HG23	4:A:549:HOH:O	2.04	0.56
1:A:147:LEU:HD21	1:A:156:LEU:HD12	1.86	0.56
1:A:102[B]:ILE:CD1	1:A:102[B]:ILE:N	2.65	0.56
1:A:132:GLN:CG	4:A:530:HOH:O	2.55	0.54
1:A:102[B]:ILE:CD1	4:A:374:HOH:O	2.56	0.54
1:A:84:ASN:O	1:A:88[B]:MET:HG3	2.09	0.53
1:A:54:LEU:HG	4:A:435:HOH:O	2.08	0.53
1:A:109:GLU:CG	4:A:533:HOH:O	2.26	0.53
1:A:147:LEU:HD21	1:A:156:LEU:CD1	2.39	0.52
1:A:123:ARG:HB3	1:A:131:LEU:HD22	1.92	0.51
1:A:26:ASP:HA	1:A:106:VAL:HG13	1.92	0.50
1:A:236:THR:HG21	4:A:549:HOH:O	2.10	0.50
1:A:235:ASP:HB3	4:A:338:HOH:O	2.10	0.50
1:A:139:ASP:O	1:A:143:HIS:HB2	2.12	0.50
1:A:159:TYR:CE1	1:A:175[B]:LEU:HG	2.48	0.49
1:A:71:GLU:OE2	1:A:86:LYS:CE	2.60	0.48
1:A:71:GLU:CD	1:A:86:LYS:HE2	2.40	0.47
1:A:54:LEU:CD2	4:A:532:HOH:O	2.61	0.46
1:A:239:LYS:HB2	1:A:273:ALA:O	2.16	0.46
1:A:102[B]:ILE:HD13	1:A:102[B]:ILE:N	2.24	0.45
1:A:140:LEU:C	1:A:140:LEU:HD23	2.40	0.45
1:A:148:ILE:HD13	1:A:148:ILE:HG21	1.76	0.43
1:A:175[B]:LEU:HD12	1:A:175[B]:LEU:HA	1.77	0.43
1:A:26:ASP:OD1	1:A:26:ASP:C	2.62	0.42
1:A:149:ASN:ND2	1:A:152:PHE:H	2.10	0.42
1:A:80:PHE:CB	1:A:95[A]:ILE:HD11	2.50	0.41
1:A:64:MET:H	1:A:64:MET:HG2	1.57	0.41
1:A:88[A]:MET:CE	4:A:314:HOH:O	2.23	0.41
1:A:109:GLU:CD	4:A:533:HOH:O	2.63	0.41
1:A:64:MET:HA	1:A:64:MET:HE3	2.03	0.41
1:A:239:LYS:HE3	4:A:567:HOH:O	2.22	0.40

All (3) 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)
4:A:315:HOH:O	4:A:538:HOH:O[1_545]	1.98	0.22
1:A:239:LYS:NZ	4:A:453:HOH:O[1_565]	2.04	0.16
4:A:333:HOH:O	4:A:444:HOH:O[1_655]	2.16	0.04

## 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	281/302 (93%)	274 (98%)	7 (2%)	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	240/252 (95%)	229 (95%)	11 (5%)	24 2

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	28[A]	THR
1	A	28[B]	THR
1	A	64	MET
1	A	95[A]	ILE
1	A	95[B]	ILE
1	A	101	LEU
1	A	128	LEU
1	A	148	ILE
1	A	208[A]	SER
1	A	208[B]	SER
1	A	269	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	51	GLN
1	A	126	HIS
1	A	149	ASN
1	A	229	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](#)

Of 3 ligands modelled in this entry, 2 are monoatomic - leaving 1 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
2	PHE	A	298	-	11,12,12	1.51	2 (18%)	11,15,15	1.36	3 (27%)

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	PHE	A	298	-	-	2/8/8/8	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	298	PHE	OXT-C	-3.14	1.20	1.30
2	A	298	PHE	CE2-CD2	2.10	1.42	1.38

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	298	PHE	OXT-C-O	-2.52	118.36	124.08
2	A	298	PHE	CD2-CG-CD1	2.26	121.60	118.23
2	A	298	PHE	CE2-CD2-CG	-2.04	117.75	120.61

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	298	PHE	O-C-CA-CB
2	A	298	PHE	OXT-C-CA-CB

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

### 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	277/302 (91%)	0.87	36 (12%) <b>7</b> <b>11</b>	5, 12, 24, 32	6 (2%)

All (36) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	130	TYR	4.5
1	A	9	VAL	4.3
1	A	126	HIS	4.2
1	A	25	ASN	4.0
1	A	7	PHE	3.8
1	A	267	ASP	3.6
1	A	234	ILE	3.5
1	A	8	VAL	3.3
1	A	276	VAL	3.2
1	A	131	LEU	3.0
1	A	27	PHE	2.9
1	A	21	SER	2.9
1	A	24	ALA	2.8
1	A	255	ALA	2.8
1	A	23	ASP	2.7
1	A	271	TRP	2.7
1	A	129	ASP	2.5
1	A	34	ASP	2.4
1	A	22	HIS	2.4
1	A	132	GLN	2.4
1	A	33	LEU	2.4
1	A	268	ALA	2.4
1	A	101	LEU	2.3
1	A	28[A]	THR	2.3
1	A	198	GLY	2.3
1	A	253	ALA	2.2
1	A	273	ALA	2.2

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Mol	Chain	Res	Type	RSRZ
1	A	19	GLY	2.2
1	A	106	VAL	2.2
1	A	183	VAL	2.2
1	A	250	LEU	2.1
1	A	281	LEU	2.1
1	A	282	VAL	2.1
1	A	148	ILE	2.1
1	A	278	PRO	2.1
1	A	142	GLY	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 oligosaccharides 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	PHE	A	298	12/12	0.93	0.07	16,17,21,25	0
3	CO	A	300	1/1	0.94	0.20	27,27,27,27	0
3	CO	A	299	1/1	1.00	0.08	10,10,10,10	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.