



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 03:33 AM UTC

PDB ID : 5NZK / pdb_00005nzk
Title : Crystal structure of UDP-glucose pyrophosphorylase from Leishmania major in complex with phenylalanine
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Deposited on : 2017-05-14
Resolution : 2.45 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

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>.

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

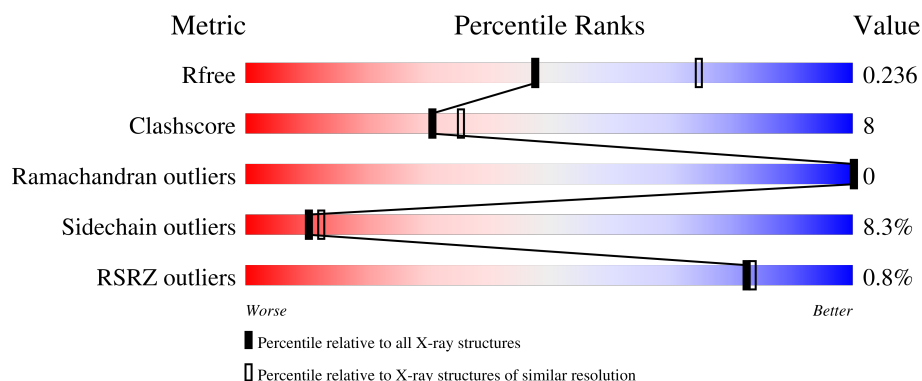
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.45 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	1190 (2.46-2.46)
Clashscore	190562	1229 (2.46-2.46)
Ramachandran outliers	187476	1218 (2.46-2.46)
Sidechain outliers	187428	1218 (2.46-2.46)
RSRZ outliers	180081	1190 (2.46-2.46)

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 ≥ 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	505	

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 3863 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.

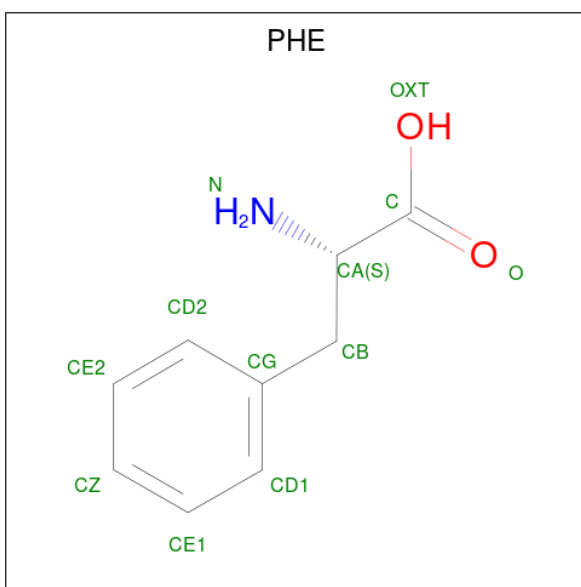
- Molecule 1 is a protein called UDP-glucose pyrophosphorylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	483	Total	C	N	O	S	0	0	0
			3730	2351	636	717	26			

There are 11 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	495	MET	-	expression tag	UNP Q4QDU3
A	496	ARG	-	expression tag	UNP Q4QDU3
A	497	PRO	-	expression tag	UNP Q4QDU3
A	498	LEU	-	expression tag	UNP Q4QDU3
A	499	GLU	-	expression tag	UNP Q4QDU3
A	500	HIS	-	expression tag	UNP Q4QDU3
A	501	HIS	-	expression tag	UNP Q4QDU3
A	502	HIS	-	expression tag	UNP Q4QDU3
A	503	HIS	-	expression tag	UNP Q4QDU3
A	504	HIS	-	expression tag	UNP Q4QDU3
A	505	HIS	-	expression tag	UNP Q4QDU3

- Molecule 2 is PHENYLALANINE (CCD ID: PHE) (formula: $C_9H_{11}NO_2$).



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

- Molecule 3 is SULFATE ION (CCD ID: SO4) (formula: O₄S).



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

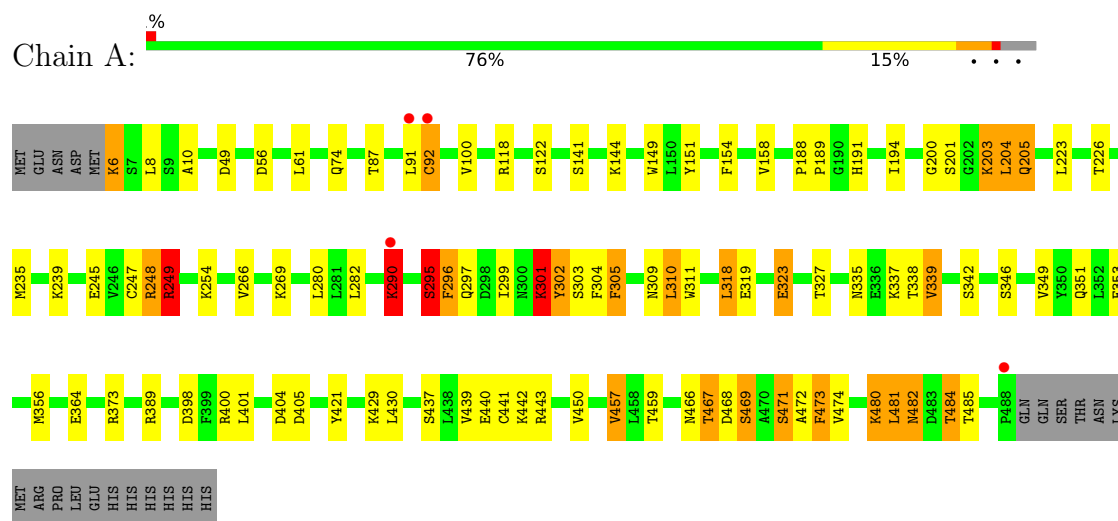
- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	116	Total 116	O 116	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: UDP-glucose pyrophosphorylase



4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α , β , γ	72.66Å 107.38Å 151.20Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	47.08 – 2.45 47.08 – 2.45	Depositor EDS
% Data completeness (in resolution range)	100.0 (47.08-2.45) 99.6 (47.08-2.45)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.04	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.12 (at 2.45Å)	Xtriage
Refinement program	PHENIX (1.11.1 _2575: ???)	Depositor
R, R_{free}	0.194 , 0.234 0.195 , 0.236	Depositor DCC
R_{free} test set	1132 reflections (5.10%)	wwPDB-VP
Wilson B-factor (Å ²)	56.1	Xtriage
Anisotropy	0.357	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 39.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	3863	wwPDB-VP
Average B, all atoms (Å ²)	62.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.12% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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: SO4

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	0.95	23/3800 (0.6%)	0.68	10/5147 (0.2%)

All (23) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	484	THR	CA-C	-6.57	1.44	1.52
1	A	203	LYS	C-O	-6.44	1.16	1.24
1	A	301	LYS	C-O	-6.44	1.16	1.24
1	A	441	CYS	C-O	-6.33	1.16	1.24
1	A	473	PHE	C-O	-6.33	1.16	1.24
1	A	204	LEU	C-O	-6.32	1.16	1.24
1	A	305	PHE	C-O	-6.08	1.16	1.23
1	A	457	VAL	C-O	-6.04	1.17	1.24
1	A	205	GLN	C-O	-5.96	1.17	1.24
1	A	480	LYS	C-O	-5.81	1.17	1.24
1	A	472	ALA	C-O	-5.63	1.16	1.24
1	A	247	CYS	C-O	-5.52	1.16	1.23
1	A	471	SER	CA-C	-5.46	1.45	1.52
1	A	200	GLY	C-O	-5.41	1.17	1.23
1	A	290	LYS	N-CA	-5.40	1.39	1.46
1	A	302	TYR	C-O	-5.39	1.17	1.24
1	A	304	PHE	C-O	-5.36	1.17	1.23
1	A	295	SER	C-O	-5.31	1.18	1.24
1	A	299	ILE	C-O	-5.26	1.17	1.24
1	A	474	VAL	C-O	-5.20	1.18	1.24
1	A	10	ALA	C-O	-5.15	1.18	1.24
1	A	296	PHE	C-O	-5.11	1.17	1.24
1	A	249	ARG	C-O	-5.02	1.17	1.23

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	467	THR	N-CA-C	10.98	123.33	111.36
1	A	203	LYS	N-CA-C	8.46	120.58	111.36
1	A	471	SER	CB-CA-C	-8.09	98.17	110.88
1	A	303	SER	N-CA-C	7.30	122.36	113.17
1	A	469	SER	N-CA-C	7.28	119.21	111.28
1	A	471	SER	N-CA-C	6.56	118.09	111.07
1	A	266	VAL	N-CA-C	6.00	116.51	108.11
1	A	474	VAL	N-CA-C	5.61	116.02	108.17
1	A	474	VAL	CB-CA-C	-5.46	102.70	110.83
1	A	471	SER	O-C-N	5.25	127.47	122.07

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	3730	0	3720	61	1
2	A	12	0	8	5	0
3	A	5	0	0	0	0
4	A	116	0	0	4	0
All	All	3863	0	3728	62	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 8.

All (62) 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:6:LYS:HB3	4:A:701:HOH:O	1.56	1.03
1:A:248:ARG:H	2:A:601:PHE:HZ	1.30	0.77
1:A:6:LYS:HB3	1:A:6:LYS:NZ	1.89	0.75
1:A:248:ARG:HG3	1:A:248:ARG:HH11	1.53	0.74
1:A:248:ARG:N	2:A:601:PHE:HZ	1.86	0.72
1:A:440:GLU:HB2	1:A:459:THR:HG22	1.70	0.72

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:481:LEU:C	1:A:482:ASN:HD22	1.97	0.72
1:A:481:LEU:C	1:A:482:ASN:ND2	2.54	0.65
1:A:373:ARG:H	2:A:601:PHE:HA	1.61	0.65
1:A:290:LYS:HD2	1:A:290:LYS:H	1.64	0.62
1:A:205:GLN:H	1:A:205:GLN:CD	2.06	0.62
1:A:295:SER:OG	1:A:301:LYS:NZ	2.26	0.59
1:A:223:LEU:HD13	1:A:401:LEU:HD12	1.84	0.58
2:A:601:PHE:HD2	4:A:815:HOH:O	1.86	0.58
1:A:248:ARG:HH11	1:A:248:ARG:CG	2.17	0.57
1:A:439:VAL:HG13	1:A:440:GLU:HG2	1.87	0.57
1:A:201:SER:OG	1:A:203:LYS:HG3	2.05	0.57
1:A:290:LYS:H	1:A:290:LYS:CD	2.13	0.56
1:A:149:TRP:CD1	1:A:149:TRP:H	2.24	0.55
1:A:74:GLN:OE1	1:A:122:SER:HB2	2.08	0.53
1:A:473:PHE:C	1:A:473:PHE:CD1	2.85	0.53
1:A:351:GLN:NE2	4:A:703:HOH:O	2.43	0.51
1:A:421:TYR:CE1	1:A:430:LEU:HB2	2.47	0.50
1:A:100:VAL:O	1:A:389:ARG:HG2	2.13	0.49
1:A:296:PHE:CD1	1:A:296:PHE:C	2.90	0.49
1:A:466:ASN:ND2	1:A:473:PHE:HB2	2.29	0.47
1:A:466:ASN:HD22	1:A:473:PHE:HB3	1.80	0.47
1:A:373:ARG:HB2	2:A:601:PHE:CD2	2.49	0.47
1:A:440:GLU:CB	1:A:459:THR:HG22	2.42	0.47
1:A:338:THR:HB	1:A:346:SER:OG	2.16	0.46
1:A:205:GLN:H	1:A:205:GLN:NE2	2.12	0.46
1:A:226:THR:HG21	1:A:400:ARG:HG2	1.98	0.46
1:A:204:LEU:HG	1:A:318:LEU:HG	1.98	0.45
1:A:480:LYS:C	1:A:481:LEU:HD23	2.41	0.45
1:A:290:LYS:HD2	1:A:290:LYS:N	2.31	0.45
1:A:339:VAL:HG23	1:A:346:SER:HB2	1.98	0.45
1:A:484:THR:OG1	1:A:485:THR:N	2.47	0.45
1:A:254:LYS:HE2	1:A:297:GLN:HB3	1.99	0.45
1:A:339:VAL:HG13	1:A:349:VAL:HG11	1.98	0.44
1:A:154:PHE:HA	1:A:158:VAL:HB	1.99	0.44
1:A:235:MET:CE	1:A:311:TRP:HB3	2.48	0.44
1:A:188:PRO:HA	1:A:189:PRO:HD3	1.84	0.43
1:A:310:LEU:HD22	1:A:356:MET:HE3	2.00	0.43
1:A:302:TYR:HA	4:A:711:HOH:O	2.18	0.43
1:A:8:LEU:HD23	1:A:8:LEU:HA	1.85	0.43
1:A:466:ASN:ND2	1:A:473:PHE:CB	2.82	0.43
1:A:421:TYR:OH	1:A:450:VAL:N	2.50	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:482:ASN:ND2	1:A:482:ASN:N	2.63	0.43
1:A:191:HIS:O	1:A:194:ILE:HG22	2.19	0.43
1:A:6:LYS:NZ	1:A:6:LYS:CB	2.72	0.42
1:A:319:GLU:O	1:A:323:GLU:HG2	2.20	0.42
1:A:249:ARG:HG3	1:A:305:PHE:HD2	1.85	0.42
1:A:398:ASP:OD1	1:A:398:ASP:N	2.45	0.42
1:A:205:GLN:CD	1:A:205:GLN:N	2.77	0.41
1:A:248:ARG:CG	1:A:248:ARG:NH1	2.76	0.41
1:A:421:TYR:HE1	1:A:430:LEU:HB2	1.85	0.41
1:A:468:ASP:CG	1:A:471:SER:HB3	2.46	0.41
1:A:437:SER:HB3	1:A:457:VAL:HG13	2.03	0.41
1:A:118:ARG:HA	1:A:122:SER:O	2.21	0.41
1:A:404:ASP:OD1	1:A:405:ASP:N	2.54	0.41
1:A:144:LYS:HB2	1:A:151:TYR:CD1	2.56	0.40
1:A:245:GLU:HB2	1:A:309:ASN:HB2	2.02	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:92:CYS:CB	1:A:92:CYS:SG[3_554]	1.82	0.38

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	481/505 (95%)	472 (98%)	9 (2%)	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	410/432 (95%)	376 (92%)	34 (8%)	10	12

All (34) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	6	LYS
1	A	49	ASP
1	A	56	ASP
1	A	61	LEU
1	A	87	THR
1	A	91	LEU
1	A	92	CYS
1	A	141	SER
1	A	239	LYS
1	A	248	ARG
1	A	249	ARG
1	A	269	LYS
1	A	280	LEU
1	A	282	LEU
1	A	290	LYS
1	A	295	SER
1	A	301	LYS
1	A	310	LEU
1	A	318	LEU
1	A	323	GLU
1	A	327	THR
1	A	335	ASN
1	A	337	LYS
1	A	339	VAL
1	A	342	SER
1	A	353	GLU
1	A	364	GLU
1	A	429	LYS
1	A	442	LYS
1	A	443	ARG

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Mol	Chain	Res	Type
1	A	467	THR
1	A	469	SER
1	A	481	LEU
1	A	482	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	164	GLN
1	A	351	GLN
1	A	482	ASN

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 ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

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	SO4	A	602	-	4,4,4	0.23	0	6,6,6	0.12	0
2	PHE	A	601	-	11,12,12	0.73	0	11,15,15	1.81	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	601	-	-	5/8/8/8	0/1/1/1

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	601	PHE	CG-CB-CA	-3.68	106.61	114.13
2	A	601	PHE	OXT-C-O	-2.56	118.26	124.08
2	A	601	PHE	CZ-CE1-CD1	-2.11	117.64	120.24

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	601	PHE	C-CA-CB-CG
2	A	601	PHE	OXT-C-CA-N
2	A	601	PHE	CA-CB-CG-CD1
2	A	601	PHE	CA-CB-CG-CD2
2	A	601	PHE	N-CA-CB-CG

There are no ring outliers.

1 monomer is involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	601	PHE	5	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 [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, 95th 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 ²)	Q<0.9
1	A	483/505 (95%)	0.00	4 (0%) 82 83	41, 58, 84, 167	0

All (4) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	290	LYS	4.3
1	A	92	CYS	2.4
1	A	91	LEU	2.3
1	A	488	PRO	2.3

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, 95th 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 ²)	Q<0.9
2	PHE	A	601	12/12	0.57	0.19	66,74,103,108	0
3	SO4	A	602	5/5	0.93	0.13	66,66,77,86	0

6.5 Other polymers [i](#)

There are no such residues in this entry.