



# Full wwPDB X-ray Structure Validation Report ⓘ

Jun 11, 2024 – 07:17 PM EDT

PDB ID : 6N1K  
Title : Full-length human phenylalanine hydroxylase (PAH) in the resting state  
Authors : Arturo, E.C.; Jaffe, E.K.  
Deposited on : 2018-11-08  
Resolution : 3.06 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)

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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  
Xtriage (Phenix) : 1.13  
EDS : 2.36.2  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.36.2

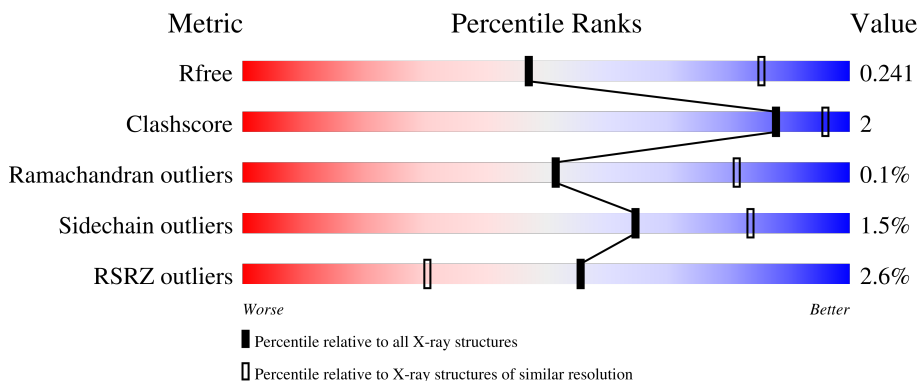
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.06 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))
$R_{free}$	130704	1754 (3.10-3.02)
Clashscore	141614	1864 (3.10-3.02)
Ramachandran outliers	138981	1794 (3.10-3.02)
Sidechain outliers	138945	1793 (3.10-3.02)
RSRZ outliers	127900	1713 (3.10-3.02)

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	451	 2% 86% 7% 7%
1	B	451	 3% 88% 7% 7%
1	C	451	 3% 88% 6% 6%
1	D	451	 2% 86% 6% 8%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard

residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	CL	B	501	-	-	X	-

## 2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 27125 atoms, of which 13436 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	H	N	O				S
1	A	419	6785	2198	3367	576	634	10	0	0	0
1	B	420	6797	2203	3371	576	637	10	0	0	0
1	C	423	6833	2214	3388	581	640	10	0	0	0
1	D	414	6695	2176	3310	569	630	10	0	0	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	29	SER	CYS	engineered mutation	UNP P00439
B	29	SER	CYS	engineered mutation	UNP P00439
C	29	SER	CYS	engineered mutation	UNP P00439
D	29	SER	CYS	engineered mutation	UNP P00439

- Molecule 2 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Cl	0	0
			1	1		
2	B	1	Total	Cl	0	0
			1	1		
2	C	1	Total	Cl	0	0
			1	1		
2	D	1	Total	Cl	0	0
			1	1		

- Molecule 3 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Fe 1 1	0	0
3	B	1	Total Fe 1 1	0	0
3	C	1	Total Fe 1 1	0	0
3	D	1	Total Fe 1 1	0	0


- Molecule 4 is water.

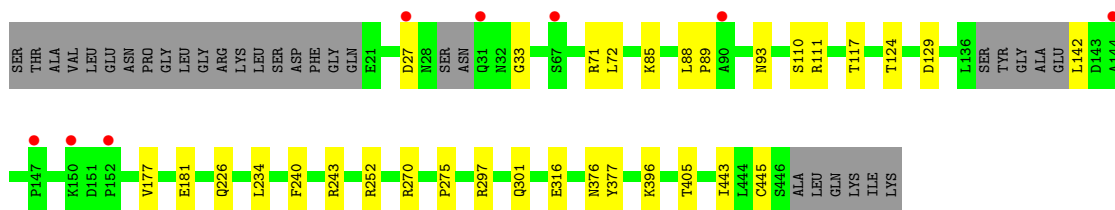
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	2	Total O 2 2	0	0
4	B	2	Total O 2 2	0	0
4	C	1	Total O 1 1	0	0
4	D	2	Total O 2 2	0	0

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

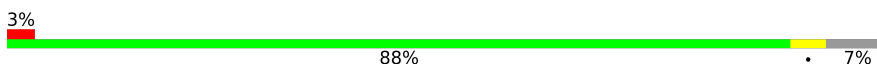
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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.

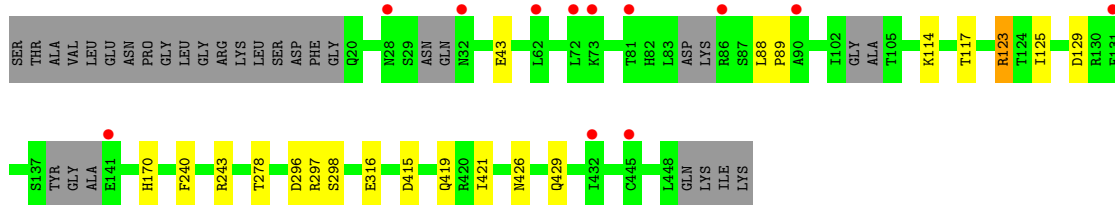
- Molecule 1: Phenylalanine-4-hydroxylase

Chain A: 




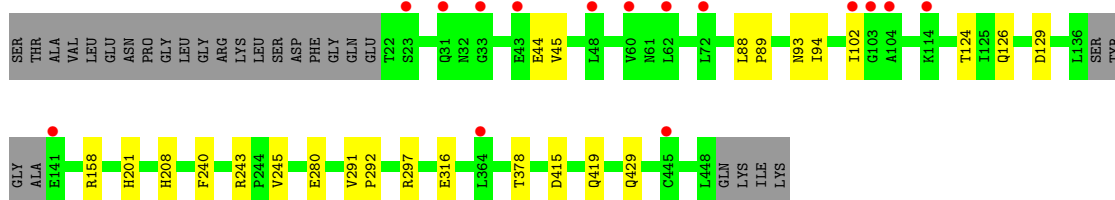
- Molecule 1: Phenylalanine-4-hydroxylase

Chain B: 




- Molecule 1: Phenylalanine-4-hydroxylase

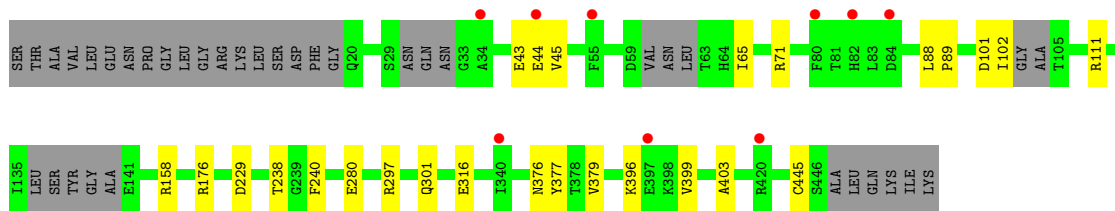
Chain C: 



- Molecule 1: Phenylalanine-4-hydroxylase

Chain D: 





## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	72.44Å 202.64Å 72.57Å 90.00° 90.30° 90.00°	Depositor
Resolution (Å)	36.29 – 3.06 36.29 – 3.06	Depositor EDS
% Data completeness (in resolution range)	99.6 (36.29-3.06) 99.1 (36.29-3.06)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.49 (at 3.06Å)	Xtrriage
Refinement program	PHENIX (1.12rc1_2807: ???)	Depositor
R, $R_{free}$	0.203 , 0.238 0.204 , 0.241	Depositor DCC
$R_{free}$ test set	1980 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	93.6	Xtrriage
Anisotropy	0.160	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.36 , 60.1	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.43$ , $\langle L^2 \rangle = 0.26$	Xtrriage
Estimated twinning fraction	0.054 for l,k,-h 0.065 for h,-k,-l 0.245 for l,-k,h	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	27125	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	115.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.19% 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: CL, FE

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	0.24	0/3503	0.41	0/4740
1	B	0.24	0/3509	0.40	0/4746
1	C	0.24	0/3531	0.40	0/4780
1	D	0.24	0/3468	0.40	0/4688
All	All	0.24	0/14011	0.40	0/18954

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 [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	3418	3367	3366	17	0
1	B	3426	3371	3371	12	0
1	C	3445	3388	3394	14	0
1	D	3385	3310	3324	14	0
2	A	1	0	0	1	0
2	B	1	0	0	3	0
2	C	1	0	0	1	0
2	D	1	0	0	1	0
3	A	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
4	A	2	0	0	0	0
4	B	2	0	0	0	0
4	C	1	0	0	0	0
4	D	2	0	0	0	0
All	All	13689	13436	13455	54	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 2.

All (54) 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:C:297:ARG:NH2	2:C:501:CL:CL	2.47	0.84
1:C:415:ASP:OD2	1:D:297:ARG:NH2	2.22	0.72
1:A:181:GLU:OE1	1:A:181:GLU:N	2.24	0.71
1:C:129:ASP:OD1	1:C:243:ARG:NH2	2.28	0.66
1:B:129:ASP:OD1	1:B:243:ARG:NH2	2.29	0.65
1:A:27:ASP:OD2	1:A:252:ARG:NH1	2.31	0.64
1:D:316:GLU:N	1:D:316:GLU:OE1	2.32	0.61
1:C:316:GLU:OE1	1:C:316:GLU:N	2.32	0.61
1:A:316:GLU:OE2	1:A:316:GLU:N	2.33	0.61
1:B:316:GLU:N	1:B:316:GLU:OE2	2.33	0.61
1:A:301:GLN:OE1	1:A:396:LYS:NZ	2.34	0.59
1:D:176:ARG:NH2	1:D:229:ASP:OD1	2.35	0.58
1:B:114:LYS:O	1:B:117:THR:OG1	2.22	0.57
1:B:123:ARG:NE	1:B:421:ILE:O	2.37	0.55
1:C:429:GLN:N	1:C:429:GLN:OE1	2.39	0.55
1:D:376:ASN:OD1	1:D:377:TYR:N	2.40	0.54
1:B:297:ARG:NH1	2:B:501:CL:CL	2.74	0.53
1:B:426:ASN:OD1	1:B:429:GLN:NE2	2.42	0.53
1:D:297:ARG:NH1	2:D:501:CL:CL	2.78	0.53
1:A:376:ASN:OD1	1:A:377:TYR:N	2.44	0.51
1:D:301:GLN:OE1	1:D:396:LYS:NZ	2.44	0.51
1:A:88:LEU:N	1:A:89:PRO:HD2	2.26	0.51
1:B:296:ASP:OD2	1:B:298:SER:OG	2.23	0.50
1:A:297:ARG:NH2	2:A:501:CL:CL	2.82	0.49
1:D:88:LEU:N	1:D:89:PRO:HD2	2.28	0.49
1:A:71:ARG:NH2	2:B:501:CL:CL	2.83	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:158:ARG:NH1	1:C:280:GLU:OE1	2.43	0.49
1:A:443:ILE:HG22	1:A:443:ILE:O	2.14	0.48
1:A:129:ASP:OD1	1:A:243:ARG:NH2	2.42	0.48
1:C:124:THR:OG1	1:C:126:GLN:OE1	2.29	0.47
1:D:158:ARG:NH1	1:D:280:GLU:OE2	2.46	0.47
1:C:208:HIS:HD1	1:D:43:GLU:CD	2.19	0.46
1:C:88:LEU:N	1:C:89:PRO:HD2	2.30	0.46
1:D:399:VAL:O	1:D:403:ALA:N	2.47	0.46
1:A:33:GLY:O	1:A:85:LYS:N	2.48	0.46
1:B:297:ARG:NH2	2:B:501:CL:CL	2.86	0.46
1:B:88:LEU:N	1:B:89:PRO:HD2	2.32	0.45
1:C:44:GLU:HG3	1:C:45:VAL:HG23	1.99	0.45
1:C:93:ASN:OD1	1:C:94:ILE:N	2.50	0.44
1:C:291:VAL:CG2	1:C:292:PRO:HD3	2.48	0.44
1:A:88:LEU:N	1:A:89:PRO:CD	2.82	0.42
1:D:88:LEU:N	1:D:89:PRO:CD	2.83	0.42
1:D:88:LEU:HG	1:D:89:PRO:HD3	2.02	0.42
1:C:297:ARG:HD2	1:D:71:ARG:HD2	2.01	0.42
1:A:177:VAL:O	1:A:226:GLN:NE2	2.51	0.42
1:C:415:ASP:O	1:C:419:GLN:N	2.49	0.41
1:B:43:GLU:O	1:B:43:GLU:HG2	2.20	0.41
1:A:110:SER:O	1:A:111:ARG:HB3	2.21	0.41
1:B:125:ILE:HD12	1:B:170:HIS:CE1	2.56	0.41
1:B:415:ASP:O	1:B:419:GLN:N	2.53	0.41
1:A:270:ARG:NH1	1:A:275:PRO:O	2.46	0.41
1:A:71:ARG:O	1:A:72:LEU:HB2	2.21	0.41
1:D:101:ASP:O	1:D:102:ILE:HG13	2.21	0.40
1:A:142:LEU:N	1:A:142:LEU:HD12	2.37	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	413/451 (92%)	395 (96%)	18 (4%)	0	100	100
1	B	410/451 (91%)	392 (96%)	18 (4%)	0	100	100
1	C	419/451 (93%)	399 (95%)	20 (5%)	0	100	100
1	D	404/451 (90%)	387 (96%)	16 (4%)	1 (0%)	47	77
All	All	1646/1804 (91%)	1573 (96%)	72 (4%)	1 (0%)	51	81

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	111	ARG

### 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	373/398 (94%)	366 (98%)	7 (2%)	57	79
1	B	375/398 (94%)	372 (99%)	3 (1%)	81	91
1	C	376/398 (94%)	371 (99%)	5 (1%)	69	86
1	D	370/398 (93%)	363 (98%)	7 (2%)	57	79
All	All	1494/1592 (94%)	1472 (98%)	22 (2%)	65	83

All (22) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	93	ASN
1	A	117	THR
1	A	124	THR
1	A	234	LEU
1	A	240	PHE
1	A	405	THR
1	A	445	CYS
1	B	123	ARG
1	B	240	PHE
1	B	278	THR

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Mol	Chain	Res	Type
1	C	102	ILE
1	C	201	HIS
1	C	240	PHE
1	C	245	VAL
1	C	378	THR
1	D	44	GLU
1	D	45	VAL
1	D	65	ILE
1	D	238	THR
1	D	240	PHE
1	D	379	VAL
1	D	445	CYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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 monosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

Of 8 ligands modelled in this entry, 8 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

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	419/451 (92%)	0.25	8 (1%) 66 43	59, 94, 156, 261	0
1	B	420/451 (93%)	0.31	12 (2%) 51 26	63, 97, 154, 298	0
1	C	423/451 (93%)	0.34	15 (3%) 44 22	62, 100, 167, 223	0
1	D	414/451 (91%)	0.26	9 (2%) 62 38	65, 104, 158, 364	0
All	All	1676/1804 (92%)	0.29	44 (2%) 56 30	59, 99, 159, 364	0

All (44) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	103	GLY	7.9
1	D	82	HIS	6.0
1	C	445	CYS	5.0
1	C	72	LEU	3.5
1	C	102	ILE	3.3
1	A	27	ASP	3.2
1	A	31	GLN	3.2
1	B	141	GLU	3.1
1	D	340	ILE	3.1
1	D	44	GLU	3.1
1	A	90	ALA	3.1
1	D	34	ALA	3.0
1	C	141	GLU	3.0
1	C	114	LYS	3.0
1	D	55	PHE	2.9
1	B	445	CYS	2.9
1	D	397	GLU	2.8
1	C	104	ALA	2.7
1	A	152	PRO	2.6
1	B	72	LEU	2.6
1	C	364	LEU	2.6

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Mol	Chain	Res	Type	RSRZ
1	A	147	PRO	2.6
1	D	84	ASP	2.6
1	B	32	ASN	2.6
1	C	33	GLY	2.6
1	C	31	GLN	2.5
1	D	420	ARG	2.5
1	B	86	ARG	2.5
1	C	43	GLU	2.4
1	A	144	ALA	2.3
1	B	28	ASN	2.3
1	B	81	THR	2.3
1	C	48	LEU	2.2
1	B	131	PHE	2.2
1	A	67	SER	2.2
1	C	62	LEU	2.2
1	B	73	LYS	2.2
1	C	23	SER	2.1
1	D	80	PHE	2.1
1	B	62	LEU	2.1
1	B	432	ILE	2.0
1	C	60	VAL	2.0
1	A	150	LYS	2.0
1	B	90	ALA	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 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.

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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
3	FE	D	502	1/1	0.79	0.31	111,111,111,111	0
2	CL	C	501	1/1	0.88	0.29	99,99,99,99	0
3	FE	C	502	1/1	0.90	0.39	125,125,125,125	0
2	CL	A	501	1/1	0.91	0.53	100,100,100,100	0
3	FE	A	502	1/1	0.91	0.41	123,123,123,123	0
3	FE	B	502	1/1	0.92	0.35	111,111,111,111	0
2	CL	D	501	1/1	0.95	0.43	99,99,99,99	0
2	CL	B	501	1/1	0.98	0.34	99,99,99,99	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.