



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 15, 2017 – 02:20 PM EDT

PDB ID : 2QTL  
Title : Crystal Structure of the FAD-containing FNR-like Module of Human Methionine Synthase Reductase  
Authors : Wolthers, K.R.; Lou, X.; Toogood, H.S.; Leys, D.; Scrutton, N.S.  
Deposited on : unknown  
Resolution : 1.90 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.

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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 : 1.7.2 (RC1), CSD as538be (2017)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20030345  
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)  
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) : rb-20030345

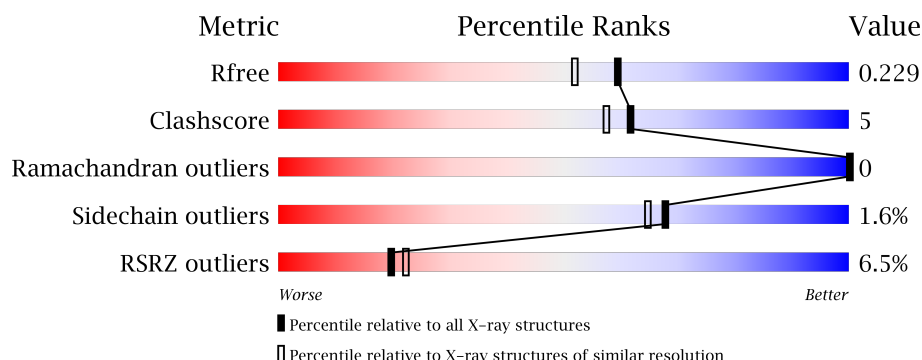
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.90 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))
$R_{free}$	100719	5047 (1.90-1.90)
Clashscore	112137	5731 (1.90-1.90)
Ramachandran outliers	110173	5669 (1.90-1.90)
Sidechain outliers	110143	5670 (1.90-1.90)
RSRZ outliers	101464	5100 (1.90-1.90)

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	A	539	<div> <div>5%</div> <div>72%</div> <div>11%</div> <div>17%</div> </div>

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 3999 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 Methionine synthase reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	448	Total	C	N	O	S	5	18	0
			3575	2304	603	652	16			

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	160	GLY	-	EXPRESSION TAG	UNP Q9UBK8
A	161	SER	-	EXPRESSION TAG	UNP Q9UBK8
A	162	PRO	-	EXPRESSION TAG	UNP Q9UBK8
A	163	GLU	-	EXPRESSION TAG	UNP Q9UBK8
A	164	PHE	-	EXPRESSION TAG	UNP Q9UBK8
A	340	CSO	CYS	MODIFIED RESIDUE	UNP Q9UBK8
A	364	CSO	CYS	MODIFIED RESIDUE	UNP Q9UBK8
A	421	CSO	CYS	MODIFIED RESIDUE	UNP Q9UBK8
A	523	PHE	SER	isoform	UNP Q9UBK8

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula:  $C_{27}H_{33}N_9O_{15}P_2$ ).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			43	22	4	15	2		

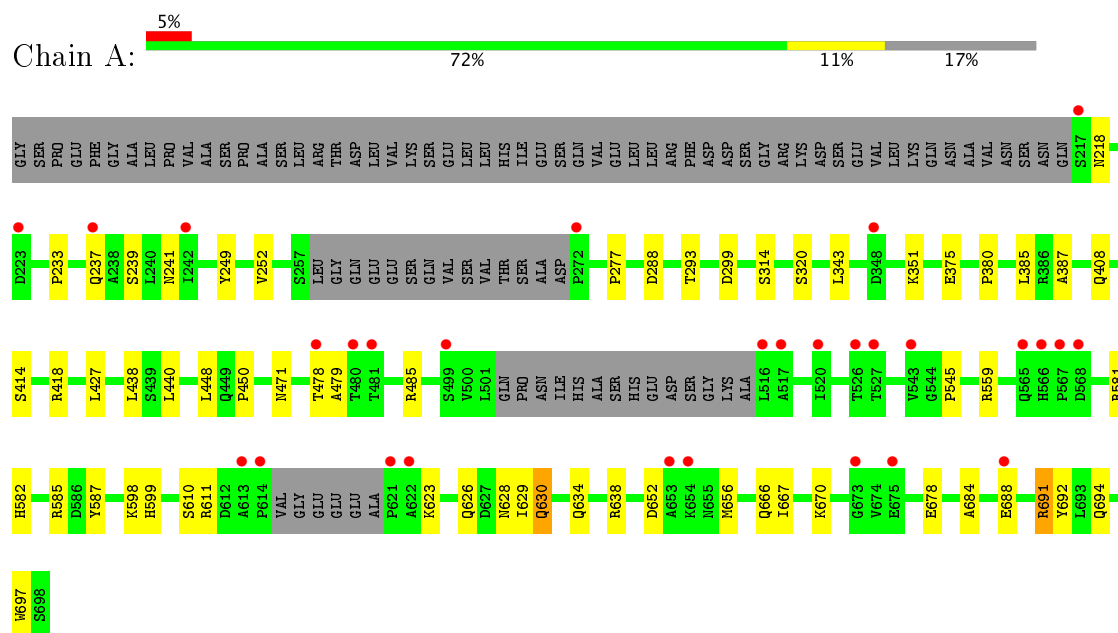
- Molecule 3 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	381	Total O 381 381	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 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: Methionine synthase reductase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	52.64Å 67.30Å 78.82Å 90.00° 107.69° 90.00°	Depositor
Resolution (Å)	19.85 – 1.90 19.85 – 1.90	Depositor EDS
% Data completeness (in resolution range)	100.0 (19.85-1.90) 98.0 (19.85-1.90)	Depositor EDS
$R_{merge}$	0.04	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.23 (at 1.90Å)	Xtriage
Refinement program	REFMAC	Depositor
R, $R_{free}$	0.184 , 0.232 0.181 , 0.229	Depositor DCC
$R_{free}$ test set	2034 reflections (5.27%)	DCC
Wilson B-factor (Å <sup>2</sup> )	30.3	Xtriage
Anisotropy	0.015	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 52.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.017 for h,-k,-h-l	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	3999	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	31.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.28% 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: CSO, FAD

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	0.73	0/3691	0.73	5/5010 (0.1%)

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	691	ARG	NE-CZ-NH1	7.17	123.88	120.30
1	A	288	ASP	CB-CG-OD1	6.48	124.13	118.30
1	A	691	ARG	NE-CZ-NH2	-5.90	117.35	120.30
1	A	559	ARG	NE-CZ-NH2	-5.23	117.69	120.30
1	A	320	SER	N-CA-CB	-5.06	102.92	110.50

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	3575	0	3561	37	0
2	A	43	0	26	0	0
3	A	381	0	0	3	0
All	All	3999	0	3587	37	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 5.

All (37) 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:218[A]:ASN:ND2	3:A:1081:HOH:O	1.70	1.23
1:A:585[B]:ARG:HH11	1:A:585[B]:ARG:HG3	1.26	1.00
1:A:241:ASN:HD22	1:A:408:GLN:HE22	1.36	0.71
1:A:241:ASN:ND2	1:A:408:GLN:HE22	1.91	0.69
1:A:380:PRO:HG2	1:A:427:LEU:HD22	1.78	0.66
1:A:233:PRO:HG3	1:A:237[B]:GLN:HE21	1.64	0.61
1:A:252:VAL:HG22	1:A:343:LEU:CD2	2.30	0.61
1:A:585[B]:ARG:HH11	1:A:585[B]:ARG:CG	2.08	0.60
1:A:634:GLN:HE21	1:A:638:ARG:HH12	1.53	0.56
1:A:252:VAL:HG11	1:A:438:LEU:HD23	1.88	0.56
1:A:375:GLU:OE1	1:A:448:LEU:HD12	2.05	0.55
1:A:585[B]:ARG:HG3	1:A:585[B]:ARG:NH1	2.06	0.53
1:A:652[B]:ASP:HA	1:A:697:TRP:HB2	1.90	0.53
1:A:652[A]:ASP:HA	1:A:697:TRP:HB2	1.91	0.53
1:A:277:PRO:HG2	1:A:299:ASP:HB3	1.92	0.51
1:A:629:ILE:HG22	1:A:667:ILE:HD11	1.93	0.51
1:A:249:TYR:CD2	1:A:351:LYS:HD3	2.47	0.50
1:A:385:LEU:HD21	1:A:427:LEU:HD21	1.94	0.50
1:A:479:ALA:HB2	1:A:485:ARG:NH2	2.27	0.49
1:A:387:ALA:HB1	1:A:440:LEU:HD11	1.95	0.49
1:A:252:VAL:HG22	1:A:343:LEU:HD21	1.94	0.49
1:A:629:ILE:HG22	1:A:667:ILE:CD1	2.43	0.48
1:A:694:GLN:NE2	3:A:709:HOH:O	2.46	0.48
1:A:314:SER:HB3	1:A:450:PRO:HB2	1.98	0.45
1:A:666:GLN:O	1:A:670[A]:LYS:HG3	2.17	0.45
1:A:610:SER:HA	1:A:623:LYS:HG3	1.99	0.45
1:A:626:GLN:O	1:A:630:GLN:HG3	2.17	0.45
1:A:684:ALA:O	1:A:688:GLU:HG3	2.17	0.44
1:A:691:ARG:NH2	3:A:982:HOH:O	2.34	0.44
1:A:293:THR:OG1	1:A:471[A]:ASN:OD1	2.29	0.42
1:A:414:SER:HB3	1:A:418[A]:ARG:HH21	1.84	0.42
1:A:598:LYS:HD3	1:A:599:HIS:CE1	2.55	0.42
1:A:478:THR:HG22	1:A:478:THR:O	2.18	0.42
1:A:582:HIS:HB2	1:A:585[A]:ARG:HB2	2.02	0.41
1:A:581:ARG:HD3	1:A:611:ARG:NH1	2.34	0.41
1:A:545:PRO:HG3	1:A:656:MET:HG3	2.03	0.41
1:A:478:THR:CG2	1:A:478:THR:O	2.69	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	455/539 (84%)	447 (98%)	8 (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	388/471 (82%)	382 (98%)	6 (2%)	70	67

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	239	SER
1	A	587	TYR
1	A	628	ASN
1	A	630	GLN
1	A	678	GLU
1	A	692	TYR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (10) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	241	ASN
1	A	253	HIS

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Mol	Chain	Res	Type
1	A	319	ASN
1	A	367	GLN
1	A	558	HIS
1	A	563	GLN
1	A	628	ASN
1	A	634	GLN
1	A	644	ASN
1	A	694	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](#)

3 non-standard protein/DNA/RNA residues 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	$\# Z  > 2$
1	CSO	A	340	1	4,6,7	0.38	0	1,6,8	1.73	0
1	CSO	A	364	1	4,6,7	1.06	1 (25%)	1,6,8	1.93	0
1	CSO	A	421	1	4,6,7	1.00	0	1,6,8	1.83	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
1	CSO	A	340	1	-	0/1/5/7	0/0/0/0
1	CSO	A	364	1	-	0/1/5/7	0/0/0/0
1	CSO	A	421	1	-	0/1/5/7	0/0/0/0

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	364	CSO	CA-C	2.00	1.52	1.50

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.

## 5.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

1 ligand is 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	FAD	A	700	-	42,46,58	1.67	5 (11%)	46,70,89	1.77	6 (13%)

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	FAD	A	700	-	-	0/28/43/50	0/4/4/6

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	700	FAD	C4-N3	2.53	1.37	1.33

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	700	FAD	C5X-N5	2.59	1.39	1.35
2	A	700	FAD	C4X-N5	4.02	1.39	1.33
2	A	700	FAD	C10-N1	4.73	1.39	1.33
2	A	700	FAD	C1'-N10	6.47	1.55	1.48

All (6) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	700	FAD	C4X-C4-N3	-3.93	117.89	123.48
2	A	700	FAD	C1'-N10-C10	-2.67	115.77	118.50
2	A	700	FAD	O5B-C5B-C4B	-2.26	100.99	109.00
2	A	700	FAD	C5X-C9A-N10	2.42	119.45	117.66
2	A	700	FAD	C1'-N10-C9A	3.22	121.30	118.35
2	A	700	FAD	C4-N3-C2	8.60	122.68	115.16

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 ⓘ

There are no such residues in this entry.

## 5.8 Polymer linkage issues ⓘ

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	445/539 (82%)	0.20	29 (6%)	20 22	18, 29, 47, 55	5 (1%)

All (29) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	614	PRO	5.6
1	A	526	THR	4.9
1	A	568	ASP	4.6
1	A	516	LEU	4.4
1	A	613	ALA	4.4
1	A	527	THR	3.9
1	A	621	PRO	3.6
1	A	480	THR	3.5
1	A	673	GLY	3.3
1	A	272	PRO	3.2
1	A	217	SER	3.2
1	A	478	THR	3.2
1	A	237[A]	GLN	2.9
1	A	223	ASP	2.8
1	A	499	SER	2.8
1	A	654	LYS	2.7
1	A	242	ILE	2.6
1	A	481	THR	2.6
1	A	653	ALA	2.6
1	A	517	ALA	2.6
1	A	675	GLU	2.5
1	A	543	VAL	2.5
1	A	566	HIS	2.5
1	A	348	ASP	2.4
1	A	567	PRO	2.2
1	A	622	ALA	2.1
1	A	520	ILE	2.1

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Mol	Chain	Res	Type	RSRZ
1	A	688	GLU	2.0
1	A	565	GLN	2.0

## 6.2 Non-standard residues in protein, DNA, RNA chains [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(Å <sup>2</sup> )	Q<0.9
1	CSO	A	421	7/8	0.93	0.10	-	32,32,37,37	0
1	CSO	A	364	7/8	0.92	0.12	-	31,33,42,43	0
1	CSO	A	340	7/8	0.95	0.06	-	26,26,27,34	0

## 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(Å <sup>2</sup> )	Q<0.9
2	FAD	A	700	43/53	0.97	0.09	-0.45	14,19,39,42	8

## 6.5 Other polymers [i](#)

There are no such residues in this entry.