



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 5, 2026 – 02:44 AM UTC

PDB ID : 2PPD / pdb\_00002ppd  
Title : Oxidized H145A mutant of AfNiR bound to nitric oxide  
Authors : Tocheva, E.I.; Murphy, M.E.P.  
Deposited on : 2007-04-28  
Resolution : 1.80 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 : 4-5-2 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

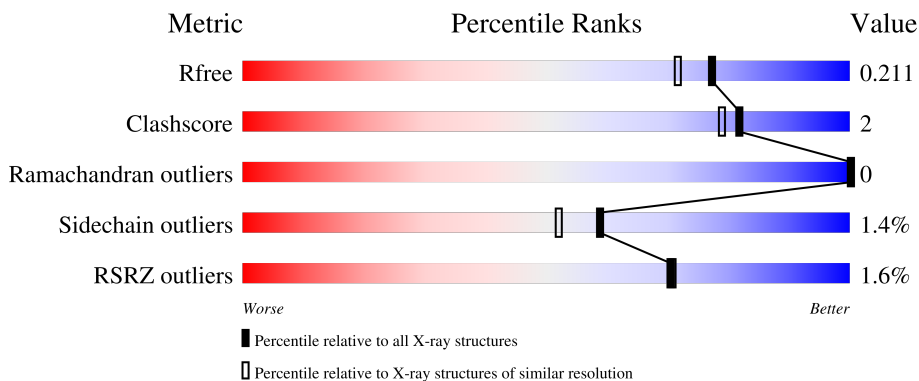
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

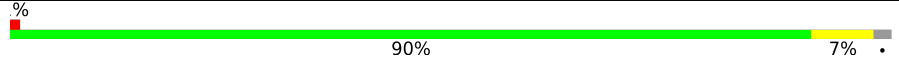
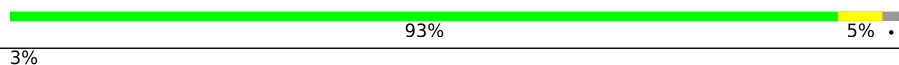
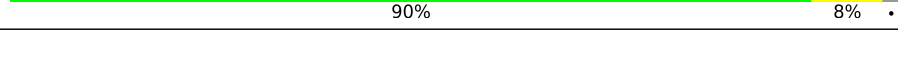
The reported resolution of this entry is 1.80 Å.

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	7662 (1.80-1.80)
Clashscore	190562	8479 (1.80-1.80)
Ramachandran outliers	187476	8391 (1.80-1.80)
Sidechain outliers	187428	8390 (1.80-1.80)
RSRZ outliers	180081	7663 (1.80-1.80)

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	343	 90% 7%
1	B	343	 93% 5%
1	C	343	 90% 8%

## 2 Entry composition

There are 7 unique types of molecules in this entry. The entry contains 8347 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 Copper-containing nitrite reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	336	2589	1657	436	485	11	0	4	0
1	B	337	2568	1643	430	484	11	0	1	0
1	C	336	2566	1642	432	481	11	0	1	0

There are 3 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	145	ALA	HIS	engineered mutation	UNP P38501
B	145	ALA	HIS	engineered mutation	UNP P38501
C	145	ALA	HIS	engineered mutation	UNP P38501

- Molecule 2 is COPPER (I) ION (CCD ID: CU1) (formula: Cu).

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

- Molecule 3 is COPPER (II) ION (CCD ID: CU) (formula: Cu).

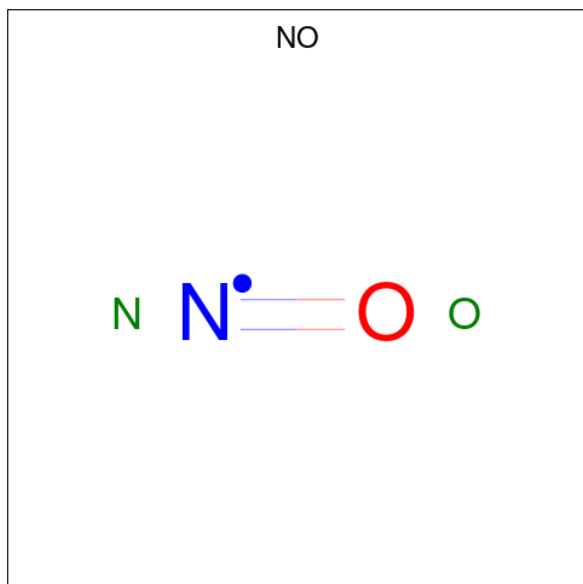
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	Cu	0	0
			1	1		
3	B	1	Total	Cu	0	0
			1	1		

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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	C	1	Total	Cu	0	0
			1	1		

- Molecule 4 is NITRIC OXIDE (CCD ID: NO) (formula: NO).



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

- Molecule 5 is 2-AMINO-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (CCD ID: TRS) (formula: C<sub>4</sub>H<sub>12</sub>NO<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
5	A	1	7	4	3	0	0

- Molecule 6 is ACETATE ION (CCD ID: ACT) (formula: C<sub>2</sub>H<sub>3</sub>O<sub>2</sub><sup>-</sup>).



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

- Molecule 7 is water.

<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
7	A	222	Total 222	O 222	0	0
7	B	219	Total 219	O 219	0	0
7	C	162	Total 162	O 162	0	0



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	60.96Å 102.06Å 145.80Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	83.62 – 1.80 83.61 – 1.80	Depositor EDS
% Data completeness (in resolution range)	98.5 (83.62-1.80) 98.5 (83.61-1.80)	Depositor EDS
$R_{merge}$	0.06	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.07 (at 1.79Å)	Xtrriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.188 , 0.212 0.188 , 0.211	Depositor DCC
$R_{free}$ test set	4214 reflections (4.94%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	25.2	Xtrriage
Anisotropy	0.417	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 30.4	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	8347	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	28.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.84% 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: TRS, CU1, NO, ACT, CU

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	0.63	0/2659	0.79	0/3626
1	B	0.63	0/2638	0.82	0/3598
1	C	0.57	0/2636	0.78	0/3594
All	All	0.61	0/7933	0.79	0/10818

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	1
1	B	0	1
1	C	0	1
All	All	0	3

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	306	HIS	Peptide
1	B	306	HIS	Peptide
1	C	306	HIS	Peptide

## 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	2589	0	2522	15	0
1	B	2568	0	2494	10	0
1	C	2566	0	2495	16	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
4	A	2	0	0	0	0
4	B	2	0	0	1	0
5	A	7	0	9	0	0
6	B	4	0	3	0	0
7	A	222	0	0	0	0
7	B	219	0	0	0	0
7	C	162	0	0	0	0
All	All	8347	0	7523	38	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 (38) 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:26:HIS:HE1	1:A:74:VAL:H	1.20	0.86
1:B:26:HIS:HE1	1:B:74:VAL:H	1.34	0.73
1:A:26:HIS:CE1	1:A:74:VAL:H	2.08	0.68
1:B:26:HIS:CE1	1:B:74:VAL:H	2.13	0.66
1:A:26:HIS:HD2	1:A:27:ALA:O	1.86	0.59
1:A:22:PRO:HB2	1:A:221:ASN:HD21	1.69	0.58
1:C:26:HIS:CE1	1:C:74:VAL:H	2.23	0.57
1:C:226:ALA:O	1:C:231:LYS:HB2	2.04	0.56
1:C:257:ILE:HD12	1:C:302:ALA:HB3	1.87	0.56
1:B:22:PRO:HB2	1:B:221:ASN:HD21	1.71	0.55
1:C:26:HIS:HE1	1:C:74:VAL:H	1.54	0.55

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:22:PRO:HB2	1:C:221:ASN:HD21	1.72	0.55
1:C:69:PRO:HG3	1:C:179:GLY:HA3	1.91	0.53
1:B:88:PRO:HD2	1:B:91:ASN:ND2	2.26	0.51
1:B:257:ILE:HD12	1:B:302:ALA:HB3	1.93	0.50
1:C:207:VAL:O	1:C:211:ARG:HG3	2.12	0.50
1:C:88:PRO:HD2	1:C:91:ASN:ND2	2.27	0.49
1:C:15:GLN:OE1	1:C:37:LYS:HE3	2.13	0.49
1:A:136:CYS:SG	1:A:138:PRO:HD3	2.54	0.47
1:B:98:ASP:OD1	4:B:503:NO:N	2.47	0.47
1:B:26:HIS:HD2	1:B:27:ALA:O	1.98	0.47
1:A:305:ASN:O	1:A:311:ALA:HB2	2.16	0.46
1:A:257:ILE:HD12	1:A:302:ALA:HB3	1.98	0.45
1:A:26:HIS:HE1	1:A:74:VAL:N	2.00	0.45
1:A:128[B]:LYS:NZ	1:B:260:HIS:CD2	2.85	0.45
1:A:235:ALA:O	1:A:322:VAL:HA	2.18	0.44
1:C:180:GLU:HB3	1:C:247:GLN:HG2	1.98	0.44
1:C:22:PRO:HB2	1:C:221:ASN:ND2	2.32	0.44
1:B:188:ASP:OD1	1:B:190:ASN:HB2	2.18	0.44
1:C:301:TYR:HB2	1:C:320:PHE:HB2	2.00	0.44
1:A:300:ILE:HD13	1:A:321:LYS:HG2	2.00	0.43
1:C:132:PHE:CE1	1:C:269:LYS:HE3	2.54	0.43
1:A:307:ASN:HA	1:C:249:ASN:O	2.19	0.43
1:A:130:GLY:HA2	1:A:270:PHE:CD1	2.56	0.41
1:B:249:ASN:O	1:C:307:ASN:HA	2.21	0.41
1:C:253:ARG:HA	1:C:281:TRP:O	2.20	0.41
1:A:232:ALA:HB3	1:A:321:LYS:HE2	2.04	0.40
1:A:178:VAL:O	1:A:245:HIS:HA	2.21	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	338/343 (98%)	335 (99%)	3 (1%)	0	100	100
1	B	336/343 (98%)	333 (99%)	3 (1%)	0	100	100
1	C	335/343 (98%)	329 (98%)	6 (2%)	0	100	100
All	All	1009/1029 (98%)	997 (99%)	12 (1%)	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	267/268 (100%)	262 (98%)	5 (2%)	50	41
1	B	265/268 (99%)	260 (98%)	5 (2%)	50	41
1	C	264/268 (98%)	262 (99%)	2 (1%)	73	70
All	All	796/804 (99%)	784 (98%)	12 (2%)	59	49

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	20[A]	VAL
1	A	20[B]	VAL
1	A	221	ASN
1	A	247	GLN
1	A	332	THR
1	B	33	GLU
1	B	37	LYS
1	B	168	LYS
1	B	221	ASN
1	B	247	GLN
1	C	166	LYS
1	C	247	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (12) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	26	HIS
1	A	77	GLN
1	A	221	ASN
1	A	296	GLN
1	B	26	HIS
1	B	77	GLN
1	B	115	ASN
1	B	163	HIS
1	B	221	ASN
1	C	26	HIS
1	C	115	ASN
1	C	221	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 10 ligands modelled in this entry, 6 are monoatomic - leaving 4 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	$\# Z  > 2$
4	NO	A	503	3	0,1,1	-	-	-		
4	NO	B	503	3	0,1,1	-	-	-		
6	ACT	B	1503	-	3,3,3	0.76	0	3,3,3	1.24	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
5	TRS	A	1501	-	6,6,7	0.28	0	6,6,9	0.61	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
5	TRS	A	1501	-	-	0/6/6/9	-

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.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	503	NO	1	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, 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	336/343 (97%)	-0.21	3 (0%) 81 81	11, 23, 38, 52	4 (1%)
1	B	337/343 (98%)	-0.17	1 (0%) 90 90	14, 25, 40, 47	1 (0%)
1	C	336/343 (97%)	0.51	12 (3%) 46 46	18, 34, 49, 53	1 (0%)
All	All	1009/1029 (98%)	0.04	16 (1%) 70 71	11, 27, 45, 53	6 (0%)

All (16) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	339	GLY	3.9
1	C	90	THR	3.4
1	C	197	GLU	3.1
1	C	141	MET	3.0
1	C	34	GLY	2.8
1	C	32	ALA	2.7
1	C	31	VAL	2.5
1	C	198	ALA	2.5
1	C	202	ALA	2.4
1	C	17	VAL	2.4
1	A	33	GLU	2.3
1	B	197	GLU	2.3
1	C	35	GLY	2.3
1	C	339	GLY	2.2
1	A	168	LYS	2.2
1	C	237	VAL	2.1

### 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( $\text{\AA}^2$ )	Q<0.9
6	ACT	B	1503	4/4	0.81	0.17	40,41,41,42	0
5	TRS	A	1501	7/8	0.87	0.12	39,39,40,41	0
4	NO	B	503	2/2	0.91	0.14	27,27,27,29	0
2	CU1	C	501	1/1	0.93	0.12	45,45,45,45	0
4	NO	A	503	2/2	0.97	0.07	36,36,36,36	0
3	CU	B	502	1/1	0.99	0.02	25,25,25,25	0
3	CU	C	502	1/1	0.99	0.03	27,27,27,27	0
2	CU1	B	501	1/1	0.99	0.16	34,34,34,34	0
2	CU1	A	501	1/1	1.00	0.11	33,33,33,33	0
3	CU	A	502	1/1	1.00	0.02	19,19,19,19	0

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

There are no such residues in this entry.