



# wwPDB X-ray Structure Validation Summary Report ⓘ

Jan 31, 2016 – 11:28 PM GMT

PDB ID : 1XCP  
Title : Crystal Structure of the Nitrogenase Fe protein Phe135Trp with MgADP bound  
Authors : Jeong, M.S.; Jang, S.B.  
Deposited on : 2004-09-02  
Resolution : 3.20 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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 (RC4), CSD as536be (2015)  
Xtriage (Phenix) : 1.9-1692  
EDS : rb-20026688  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
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) : trunk26865

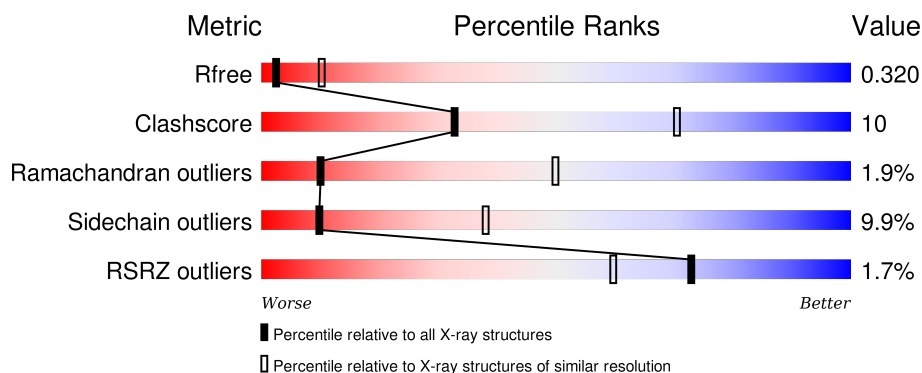
# 1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.20 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))
$R_{free}$	91344	1124 (3.24-3.16)
Clashscore	102246	1024 (3.22-3.18)
Ramachandran outliers	100387	1004 (3.22-3.18)
Sidechain outliers	100360	1003 (3.22-3.18)
RSRZ outliers	91569	1129 (3.24-3.16)

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	289	<div> <div>2%</div> <div>65%</div> <div>34%</div> <div>.</div> </div>
1	B	289	<div> <div>%</div> <div>65%</div> <div>33%</div> <div>.</div> </div>
1	C	289	<div> <div>2%</div> <div>63%</div> <div>33%</div> <div>..</div> </div>
1	D	289	<div> <div>%</div> <div>65%</div> <div>31%</div> <div>..</div> </div>

## 2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 8888 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 Nitrogenase iron protein 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	289	Total	C	N	O	S	0	0	0
			2190	1366	370	433	21			
1	B	289	Total	C	N	O	S	0	0	0
			2190	1366	370	433	21			
1	C	289	Total	C	N	O	S	0	0	0
			2190	1366	370	433	21			
1	D	289	Total	C	N	O	S	0	0	0
			2190	1366	370	433	21			

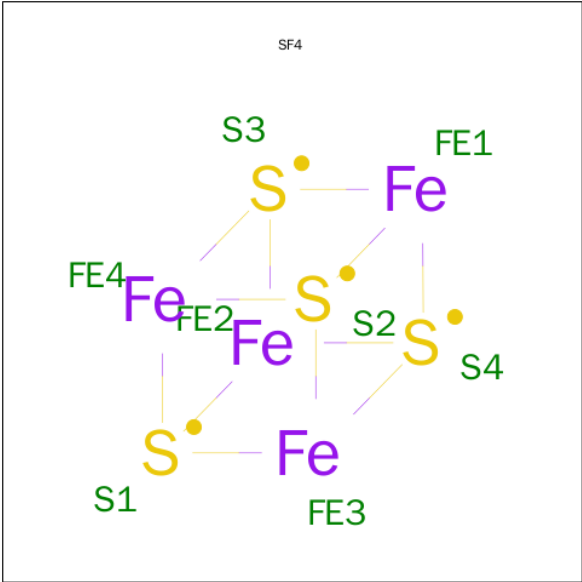
There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	135	TRP	PHE	ENGINEERED	UNP P00459
B	135	TRP	PHE	ENGINEERED	UNP P00459
C	135	TRP	PHE	ENGINEERED	UNP P00459
D	135	TRP	PHE	ENGINEERED	UNP P00459

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

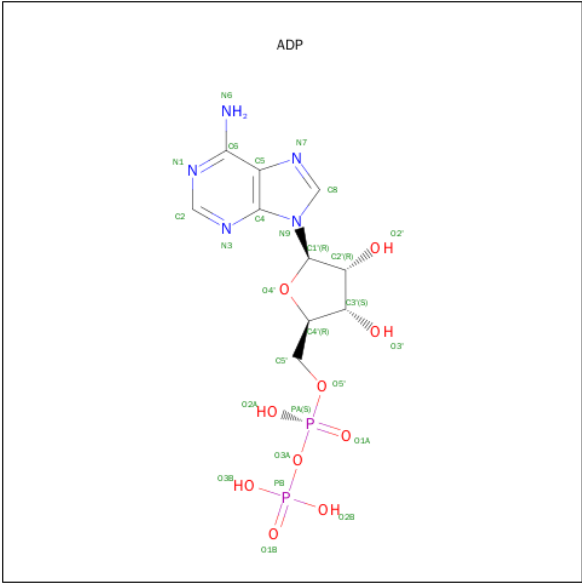
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	B	1	Total	Mg	0	0
			1	1		
2	A	1	Total	Mg	0	0
			1	1		
2	D	1	Total	Mg	0	0
			1	1		
2	C	1	Total	Mg	0	0
			1	1		

- Molecule 3 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe<sub>4</sub>S<sub>4</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	B	1	Total	Fe	S	0	0
			8	4	4		
3	C	1	Total	Fe	S	0	0
			8	4	4		

- Molecule 4 is ADENOSINE-5'-DIPHOSPHATE (three-letter code: ADP) (formula: C<sub>10</sub>H<sub>15</sub>N<sub>5</sub>O<sub>10</sub>P<sub>2</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	N	O	0	0
			27	10	5	10		

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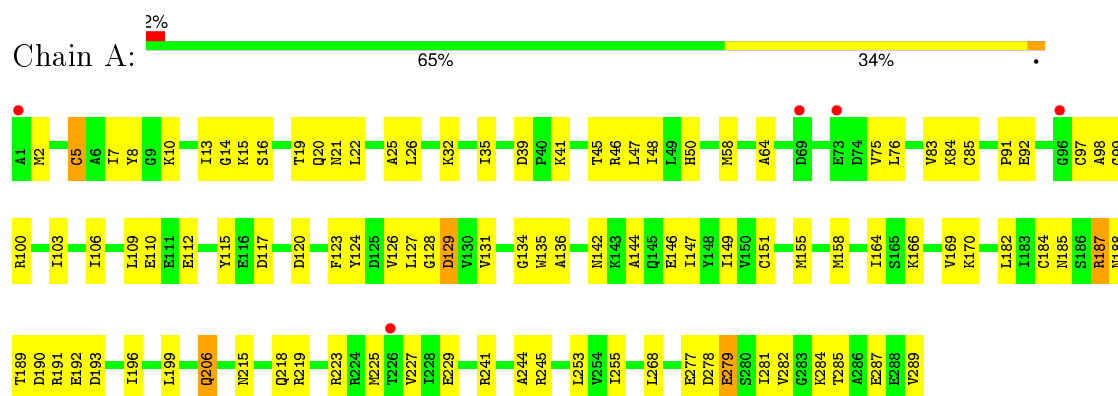
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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	B	1	Total	C	N	O	P	0	0
			27	10	5	10	2		
4	C	1	Total	C	N	O	P	0	0
			27	10	5	10	2		
4	D	1	Total	C	N	O	P	0	0
			27	10	5	10	2		

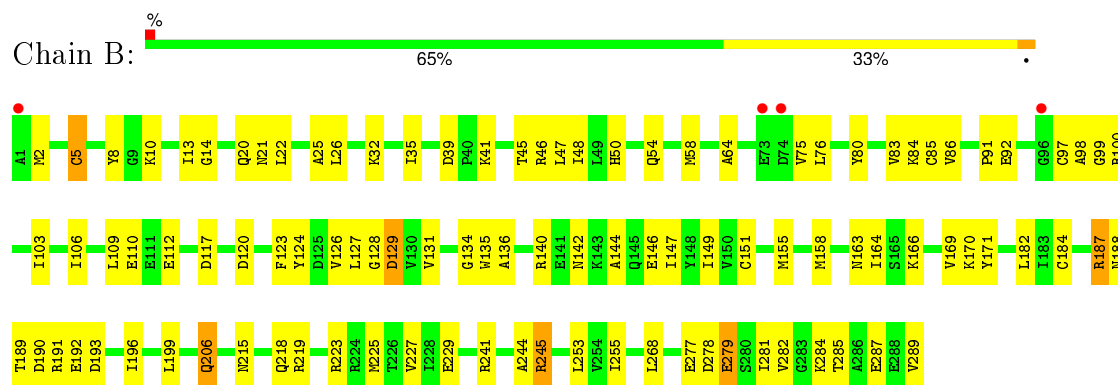
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors 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.

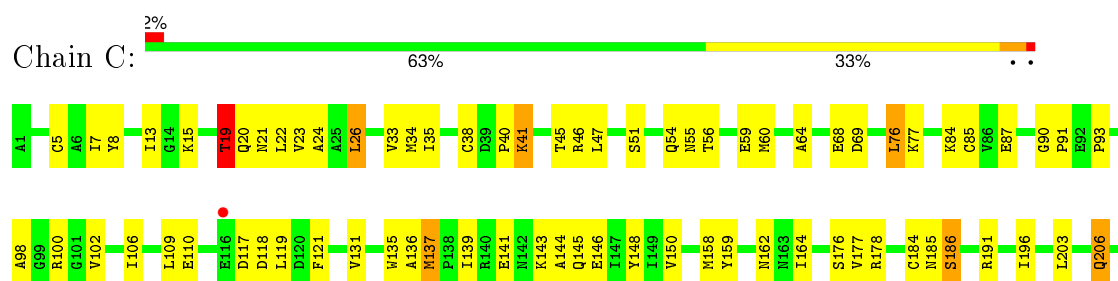
#### • Molecule 1: Nitrogenase iron protein 1

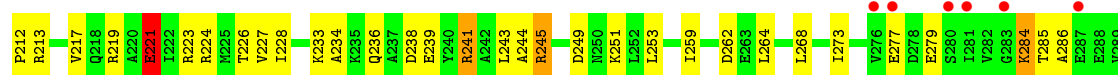


#### • Molecule 1: Nitrogenase iron protein 1

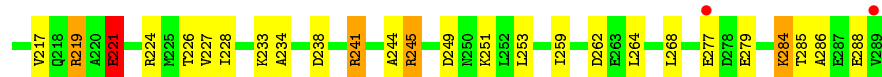


#### • Molecule 1: Nitrogenase iron protein 1





● Molecule 1: Nitrogenase iron protein 1



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	108.95Å 91.26Å 125.31Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 3.20 19.95 – 3.20	Depositor EDS
% Data completeness (in resolution range)	95.2 (20.00-3.20) 89.2 (19.95-3.20)	Depositor EDS
$R_{merge}$	0.12	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.70 (at 3.22Å)	Xtriage
Refinement program	X-PLOR	Depositor
R, $R_{free}$	0.226 , 0.322 0.238 , 0.320	Depositor DCC
$R_{free}$ test set	899 reflections (5.02%)	DCC
Wilson B-factor (Å <sup>2</sup> )	63.2	Xtriage
Anisotropy	0.626	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.26 , 59.0	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	1 of 18816 reflections (0.005%)	Xtriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	8888	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	73.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 18.02% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: SF4, MG, ADP

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	0.66	0/2215	1.58	18/2984 (0.6%)
1	B	0.65	0/2215	1.55	19/2984 (0.6%)
1	C	0.65	0/2215	1.56	21/2984 (0.7%)
1	D	0.64	0/2215	1.56	24/2984 (0.8%)
All	All	0.65	0/8860	1.56	82/11936 (0.7%)

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
1	D	0	1
All	All	0	4

There are no bond length outliers.

The worst 5 of 82 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	245	ARG	NE-CZ-NH1	23.32	131.96	120.30
1	C	245	ARG	NE-CZ-NH2	-22.18	109.21	120.30
1	D	245	ARG	NE-CZ-NH1	-22.09	109.25	120.30
1	C	100	ARG	NE-CZ-NH2	-21.89	109.35	120.30
1	A	245	ARG	NE-CZ-NH2	-21.76	109.42	120.30

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	92	GLU	Peptide
1	B	92	GLU	Peptide
1	C	90	GLY	Peptide
1	D	90	GLY	Peptide

## 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	2190	0	2198	48	0
1	B	2190	0	2198	47	0
1	C	2190	0	2197	50	0
1	D	2190	0	2197	45	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
3	B	8	0	0	0	0
3	C	8	0	0	1	0
4	A	27	0	12	3	0
4	B	27	0	12	0	0
4	C	27	0	12	0	0
4	D	27	0	12	1	0
All	All	8888	0	8838	185	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 10.

The worst 5 of 185 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:13:ILE:HD13	1:A:151:CYS:HA	1.63	0.79
1:B:13:ILE:HD13	1:B:151:CYS:HA	1.65	0.78
1:C:186:SER:HB3	1:C:212:PRO:HA	1.68	0.75
1:D:186:SER:HB3	1:D:212:PRO:HA	1.68	0.74
1:C:33:VAL:HG12	1:C:121:PHE:HB2	1.68	0.73

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	287/289 (99%)	258 (90%)	25 (9%)	4 (1%)	14	57
1	B	287/289 (99%)	258 (90%)	25 (9%)	4 (1%)	14	57
1	C	287/289 (99%)	258 (90%)	22 (8%)	7 (2%)	7	43
1	D	287/289 (99%)	258 (90%)	22 (8%)	7 (2%)	7	43
All	All	1148/1156 (99%)	1032 (90%)	94 (8%)	22 (2%)	10	50

5 of 22 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	190	ASP
1	B	190	ASP
1	C	118	ASP
1	C	137	MET
1	D	118	ASP

### 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	233/233 (100%)	211 (91%)	22 (9%)	11	41
1	B	233/233 (100%)	209 (90%)	24 (10%)	9	36
1	C	233/233 (100%)	210 (90%)	23 (10%)	10	38

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	D	233/233 (100%)	210 (90%)	23 (10%)	10	38
All	All	932/932 (100%)	840 (90%)	92 (10%)	10	38

5 of 92 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	255	ILE
1	C	68	GLU
1	D	249	ASP
1	B	277	GLU
1	C	19	THR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 33 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	173	ASN
1	C	20	GLN
1	D	163	ASN
1	B	185	ASN
1	B	206	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](#)

There are no non-standard protein/DNA/RNA residues in this entry.

## 5.5 Carbohydrates [i](#)

There are no carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 10 ligands modelled in this entry, 4 are monoatomic - leaving 6 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	ADP	A	1291	2	22,29,29	1.78	3 (13%)	27,45,45	1.96	7 (25%)
3	SF4	B	1290	1	0,12,12	0.00	-	0,24,24	0.00	-
4	ADP	B	1292	2	22,29,29	1.82	2 (9%)	27,45,45	1.89	7 (25%)
3	SF4	C	2290	1	0,12,12	0.00	-	0,24,24	0.00	-
4	ADP	C	2291	2	22,29,29	1.76	3 (13%)	27,45,45	2.10	8 (29%)
4	ADP	D	2292	2	22,29,29	1.83	4 (18%)	27,45,45	2.14	9 (33%)

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
4	ADP	A	1291	2	-	0/12/32/32	0/3/3/3
3	SF4	B	1290	1	-	0/0/48/48	4/6/5/5
4	ADP	B	1292	2	-	0/12/32/32	0/3/3/3
3	SF4	C	2290	1	-	0/0/48/48	4/6/5/5
4	ADP	C	2291	2	-	0/12/32/32	0/3/3/3
4	ADP	D	2292	2	-	0/12/32/32	0/3/3/3

The worst 5 of 12 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	C	2291	ADP	C2'-C3'	-2.40	1.46	1.53
4	D	2292	ADP	C2'-C3'	-2.38	1.46	1.53
4	A	1291	ADP	C2'-C3'	-2.05	1.47	1.53
4	D	2292	ADP	C8-N7	-2.01	1.30	1.34
4	C	2291	ADP	O4'-C1'	3.58	1.45	1.41

The worst 5 of 31 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	D	2292	ADP	C4'-O4'-C1'	-7.17	101.84	109.72
4	C	2291	ADP	C4'-O4'-C1'	-6.85	102.19	109.72
4	A	1291	ADP	C4'-O4'-C1'	-6.33	102.76	109.72

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	B	1292	ADP	C4'-O4'-C1'	-6.04	103.08	109.72
4	C	2291	ADP	O3B-PB-O1B	-3.27	100.06	110.58

There are no chirality outliers.

There are no torsion outliers.

5 of 8 ring outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	C	2290	SF4	FE3-FE4-S1-S2
3	B	1290	SF4	FE1-FE2-S3-S4
3	B	1290	SF4	FE3-FE4-S1-S2
3	B	1290	SF4	FE2-FE4-S1-S3
3	C	2290	SF4	FE1-FE3-S2-S4

3 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	1291	ADP	3	0
3	C	2290	SF4	1	0
4	D	2292	ADP	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	289/289 (100%)	0.14	5 (1%) 73 60	39, 85, 100, 100	0
1	B	289/289 (100%)	0.16	4 (1%) 78 65	39, 85, 100, 100	0
1	C	289/289 (100%)	-0.16	7 (2%) 62 47	21, 65, 99, 100	0
1	D	289/289 (100%)	-0.17	4 (1%) 78 65	20, 66, 99, 100	0
All	All	1156/1156 (100%)	-0.01	20 (1%) 73 60	20, 75, 100, 100	0

The worst 5 of 20 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	276	VAL	3.6
1	B	1	ALA	3.4
1	A	96	GLY	3.3
1	D	65	GLY	3.2
1	C	287	GLU	3.0

### 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 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( $\text{\AA}^2$ )	Q<0.9
4	ADP	D	2292	27/27	0.96	0.17	-0.61	38,46,58,61	0
4	ADP	A	1291	27/27	0.95	0.16	-0.67	48,64,71,73	0
4	ADP	C	2291	27/27	0.96	0.14	-0.92	41,51,57,60	0
4	ADP	B	1292	27/27	0.95	0.14	-1.00	50,63,70,71	0
2	MG	B	1294	1/1	0.93	0.12	-1.55	41,41,41,41	0
3	SF4	B	1290	8/8	0.96	0.08	-1.96	50,60,63,64	0
2	MG	C	2293	1/1	0.92	0.07	-2.26	7,7,7,7	0
3	SF4	C	2290	8/8	0.99	0.06	-3.05	41,49,52,53	0
2	MG	A	1293	1/1	0.92	0.08	-3.06	19,19,19,19	0
2	MG	D	2294	1/1	0.96	0.05	-3.30	2,2,2,2	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.