wwPDB EM Validation Summary Report

Feb 23, 2025 – 12:47 AM JST

PDB ID	:	9IK4
EMDB ID	:	EMD-60648
Title	:	Cryo-EM structure of Arabidopsis thaliana phosphate transporter PHO1;H1
Authors	:	Fang, S.; Zhang, X.; Zhang, P.
Deposited on	:	2024-06-26
Resolution	:	3.34 Å(reported)

This is a wwPDB EM Validation Summary 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/EMValidationReportHelp
with specific help available everywhere you see the (i) 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 (1)) were used in the production of this report:

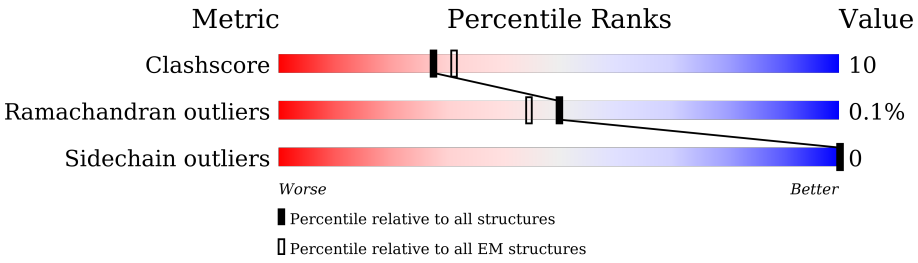
EMDB validation analysis	:	FAILED
Mogul	:	1.8.5 (274361), CSD as541be (2020)
MolProbity	:	4.02b-467
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
MapQ	:	FAILED
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.41.2

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 3.34 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)	EM structures (#Entries)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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 <=5%

Mol	Chain	Length	Quality of chain
1	A	772	62% 16% 21%
1	B	772	62% 17% 21%

2 Entry composition

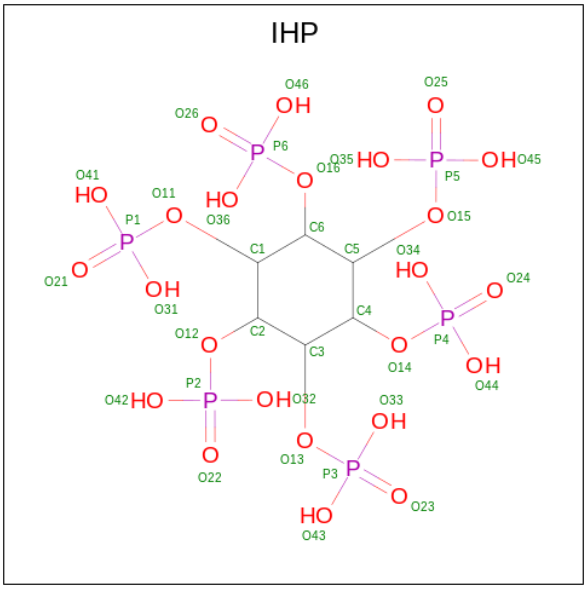
There are 3 unique types of molecules in this entry. The entry contains 10114 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 Phosphate transporter PHO1 homolog 1.

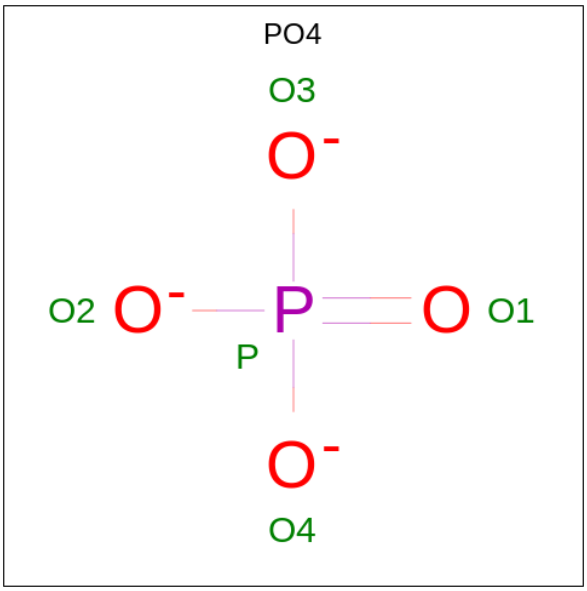
Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	607	Total	C	N	O	S	0	0
			5016	3289	834	861	32		
1	B	607	Total	C	N	O	S	0	0
			5016	3289	834	861	32		

- Molecule 2 is INOSITOL HEXAKISPHOSPHATE (three-letter code: IHP) (formula: $C_6H_{18}O_{24}P_6$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				AltConf
2	A	1	Total	C	O	P	0
			36	6	24	6	
2	B	1	Total	C	O	P	0
			36	6	24	6	

- Molecule 3 is PHOSPHATE ION (three-letter code: PO4) (formula: O_4P) (labeled as "Ligand of Interest" by depositor).



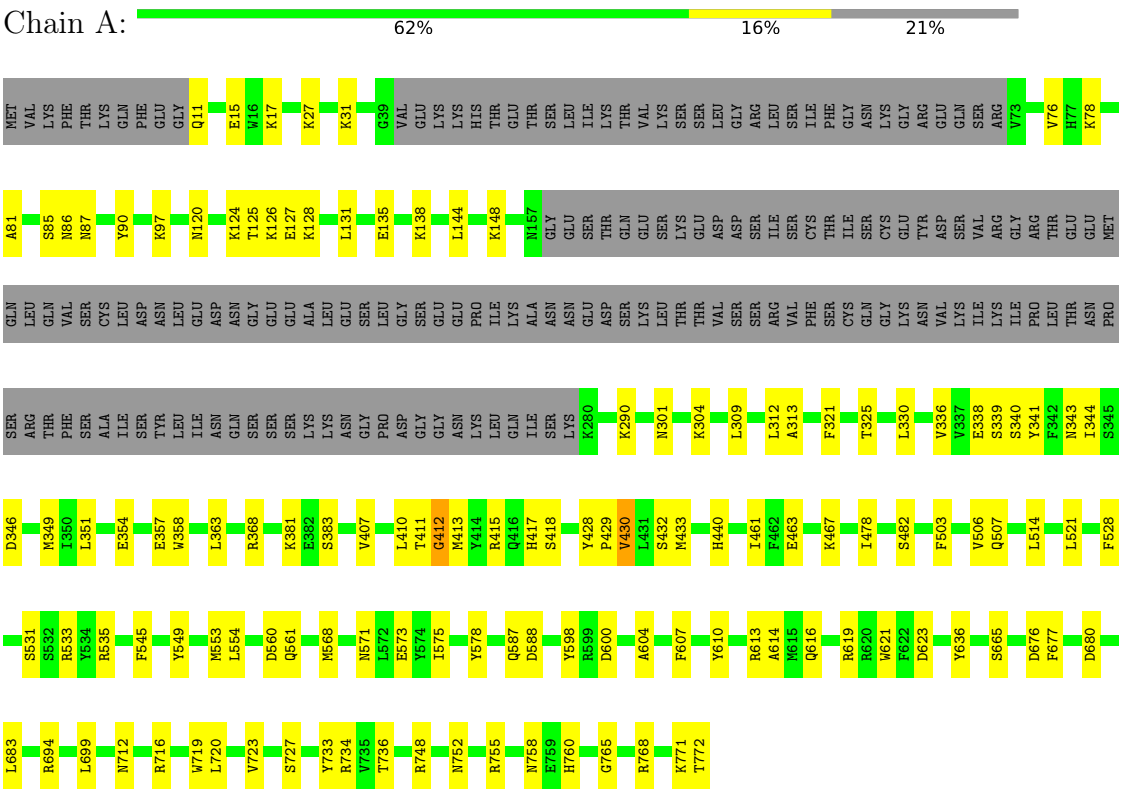
Mol	Chain	Residues	Atoms			AltConf
			Total	O	P	
3	A	1	5	4	1	0
			Total	O	P	
3	B	1	5	4	1	0

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. 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. 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.

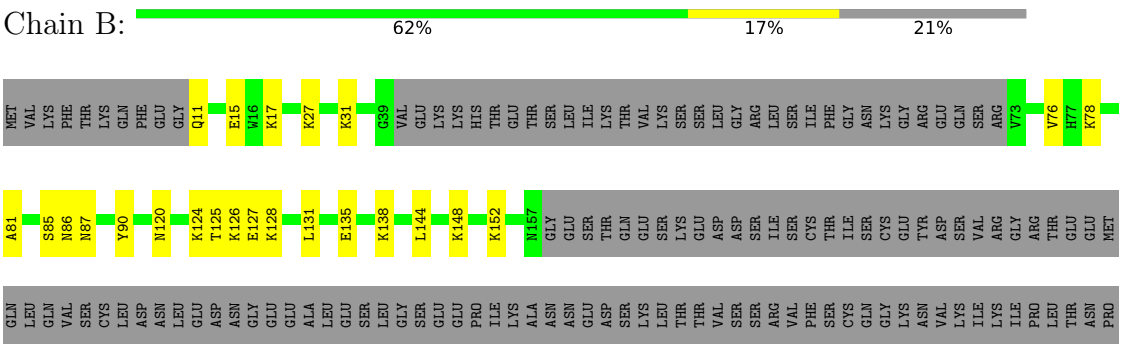
• Molecule 1: Phosphate transporter PHO1 homolog 1

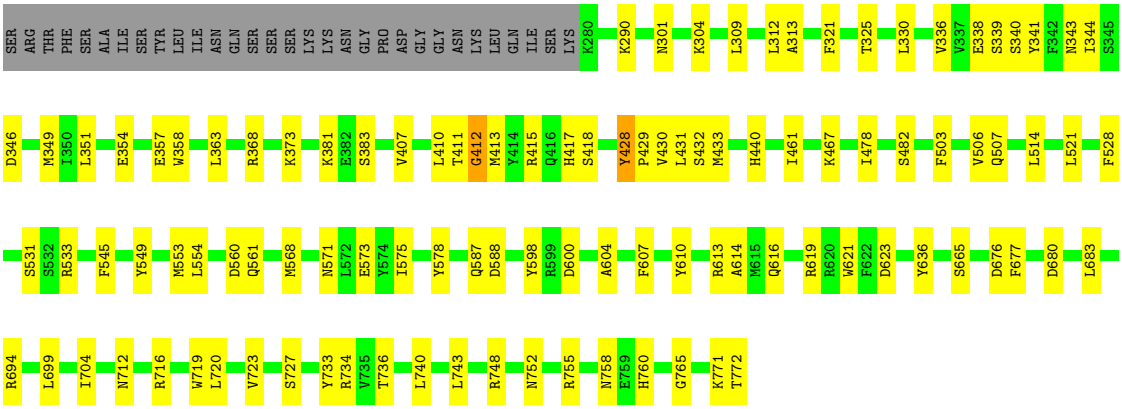
Chain A:



• Molecule 1: Phosphate transporter PHO1 homolog 1

Chain B:




SER ARG THR PHE SER ALA ILE SER TYR LEU ILE ASN GLN SER SER SER LYS LYS ASN GLY PRO ASP GLY GLY ASN LYS LEU GLN ILE SER LYS K280
K290 N301 K304 L309 L312 A313 F321 T325 L330 V336 V337 E338 S339 S340 Y341 F342 N343 I344 S345
D346 M349 I350 L351 E354 E357 W358 L363 R368 K373 K381 E382 S383 V407 L410 T411 G412 M413 Y414 R415 Q416 H417 S418 Y428 P429 V430 L431 S432 M433 H440 I461 K467 I478 S482 F503 V506 Q507 L514 L521 F528
S531 S532 R533 F545 Y549 M553 L554 D560 Q561 M568 N571 L572 E573 Y574 I575 Y578 Q587 D588 Y598 R599 D600 A604 F607 Y610 R613 A614 M615 Q616 R619 R620 W621 F622 D623 Y636 S665 D676 F677 D680 L683
R694 L699 I704 N712 R716 W719 L720 V723 S727 Y733 R734 V735 T736 L740 L743 R748 N752 R755 N758 E759 H760 G765 K771 T772

4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C2	Depositor
Number of particles used	375307	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	58.5	Depositor
Minimum defocus (nm)	8000	Depositor
Maximum defocus (nm)	20000	Depositor
Magnification	Not provided	
Image detector	GATAN K3 BIOCONTINUUM (6k x 4k)	Depositor

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: PO4, IHP

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	0.41	0/5138	0.66	6/6927 (0.1%)
1	B	0.41	0/5138	0.66	5/6927 (0.1%)
All	All	0.41	0/10276	0.66	11/13854 (0.1%)

There are no bond length outliers.

The worst 5 of 11 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	412	GLY	N-CA-C	9.87	137.78	113.10
1	B	412	GLY	N-CA-C	9.85	137.73	113.10
1	B	410	LEU	CA-CB-CG	6.94	131.26	115.30
1	A	410	LEU	CA-CB-CG	6.93	131.24	115.30
1	B	699	LEU	CA-CB-CG	5.40	127.72	115.30

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	5016	0	5086	96	0
1	B	5016	0	5086	100	0
2	A	36	0	6	4	0
2	B	36	0	6	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	5	0	0	1	0
3	B	5	0	0	1	0
All	All	10114	0	10184	193	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 193 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:B:733:TYR:CD2	1:B:736:THR:CG2	1.88	1.53
1:A:733:TYR:CD2	1:A:736:THR:CG2	1.88	1.52
1:A:733:TYR:CE2	1:A:736:THR:CG2	1.98	1.45
1:B:733:TYR:CE2	1:B:736:THR:CG2	1.98	1.45
1:B:733:TYR:CD2	1:B:736:THR:HG21	1.52	1.37

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 PDB entries followed by that with respect to all EM entries.

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	601/772 (78%)	515 (86%)	86 (14%)	0	100	100
1	B	601/772 (78%)	517 (86%)	83 (14%)	1 (0%)	44	72
All	All	1202/1544 (78%)	1032 (86%)	169 (14%)	1 (0%)	50	76

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	428	TYR

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 PDB entries followed by that with respect to all EM entries.

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	540/690 (78%)	540 (100%)	0	100	100
1	B	540/690 (78%)	540 (100%)	0	100	100
All	All	1080/1380 (78%)	1080 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 16 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	507	GLN
1	B	457	ASN
1	B	120	ASN
1	B	417	HIS
1	A	571	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)

4 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	PO4	A	802	-	4,4,4	0.92	0	6,6,6	0.75	0
3	PO4	B	1001	-	4,4,4	0.91	0	6,6,6	0.75	0
2	IHP	A	801	-	36,36,36	0.77	1 (2%)	54,60,60	1.93	17 (31%)
2	IHP	B	1002	-	36,36,36	0.77	1 (2%)	54,60,60	1.93	17 (31%)

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	IHP	A	801	-	-	5/30/54/54	0/1/1/1
2	IHP	B	1002	-	-	5/30/54/54	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	801	IHP	P3-O13	2.05	1.63	1.59
2	B	1002	IHP	P3-O13	2.03	1.63	1.59

The worst 5 of 34 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	1002	IHP	C5-C6-C1	5.27	121.94	110.41
2	A	801	IHP	C5-C6-C1	5.26	121.92	110.41
2	B	1002	IHP	O16-C6-C5	-4.93	97.07	108.69
2	A	801	IHP	O16-C6-C5	-4.93	97.07	108.69
2	A	801	IHP	O14-C4-C5	-3.72	99.92	108.69

There are no chirality outliers.

5 of 10 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	801	IHP	C2-O12-P2-O22
2	A	801	IHP	C4-O14-P4-O44
2	B	1002	IHP	C2-O12-P2-O22
2	B	1002	IHP	C4-O14-P4-O44
2	A	801	IHP	C4-O14-P4-O24

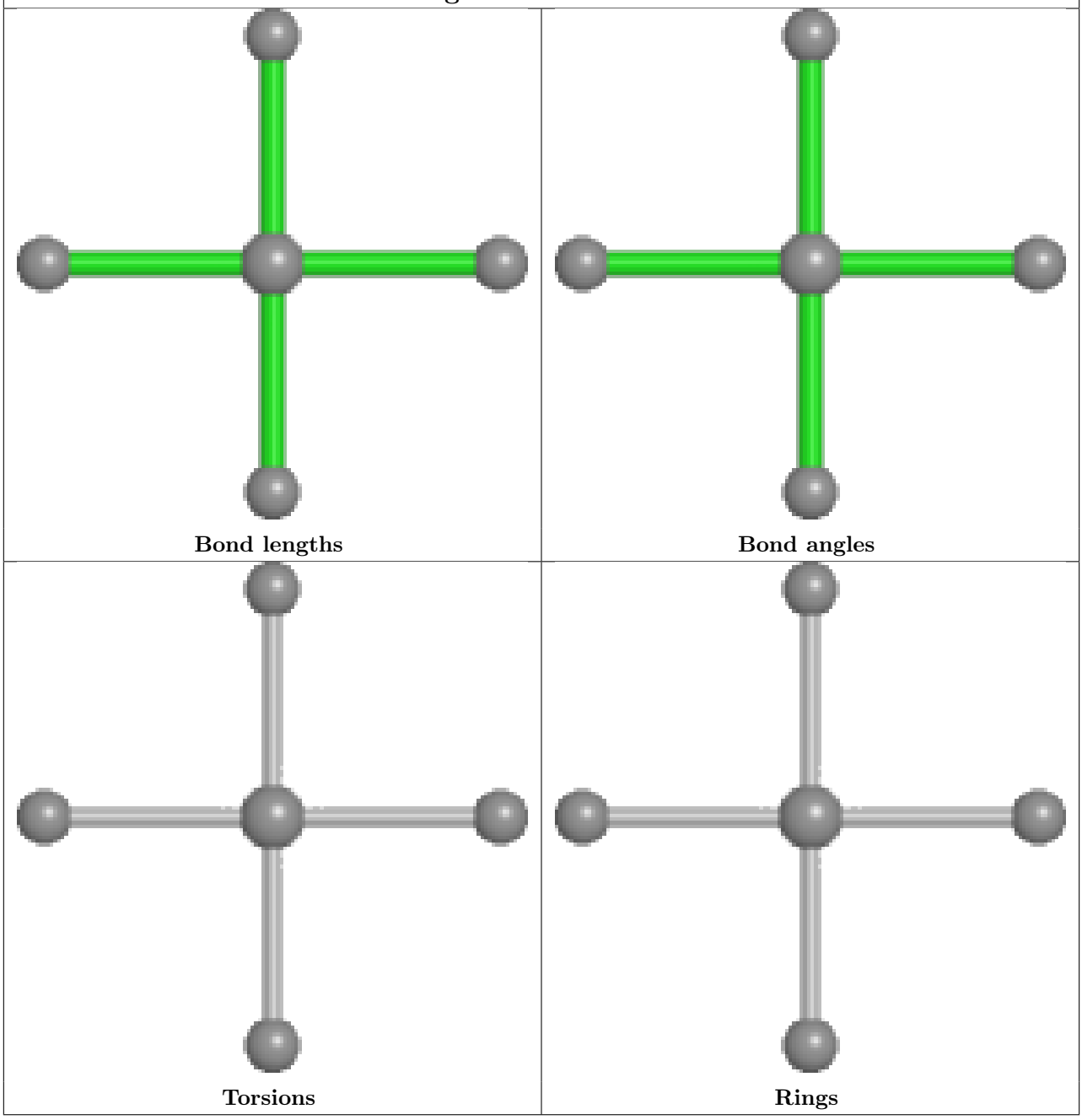
There are no ring outliers.

4 monomers are involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	802	PO4	1	0
3	B	1001	PO4	1	0
2	A	801	IHP	4	0
2	B	1002	IHP	4	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

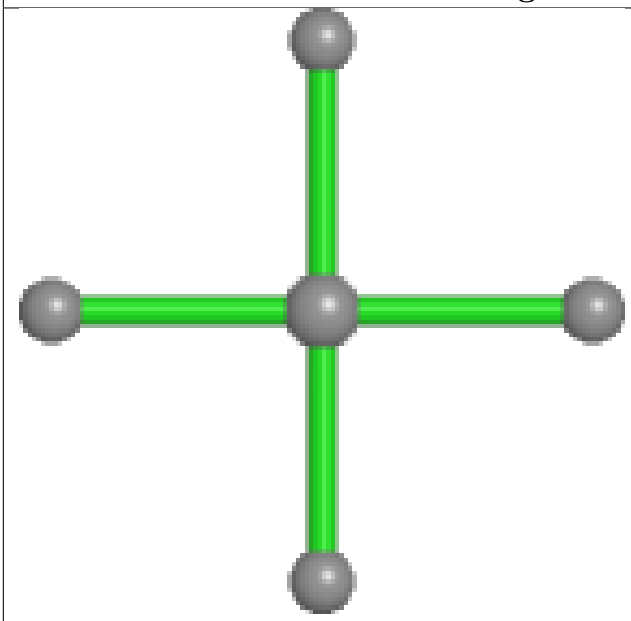
Ligand PO4 A 802



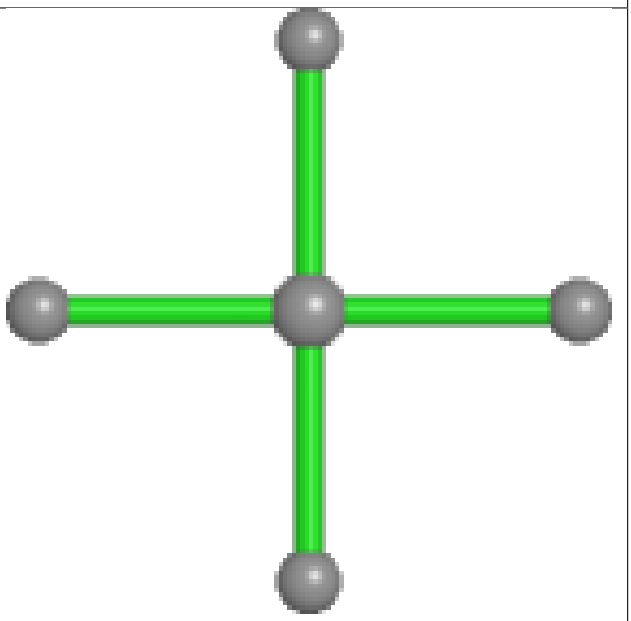
Bond lengths **Bond angles**

Torsions **Rings**

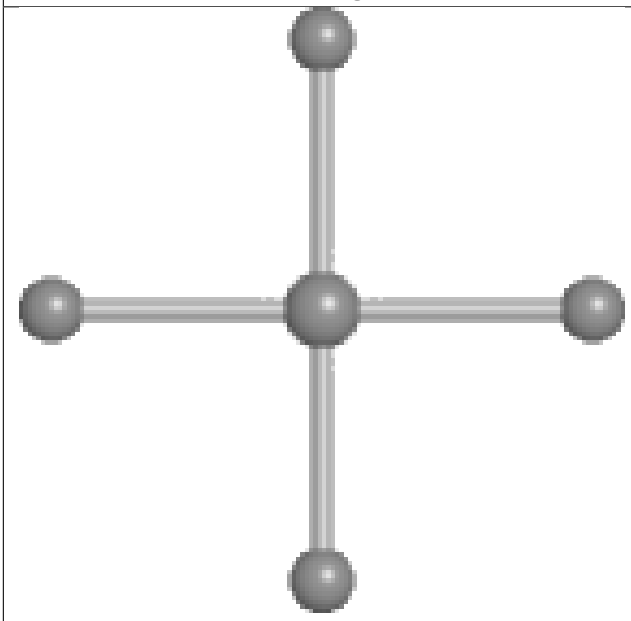
Ligand PO4 B 1001



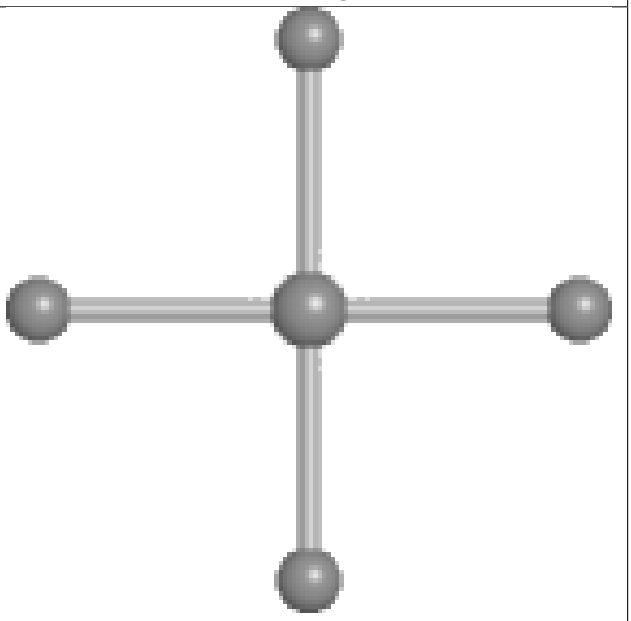
Bond lengths



Bond angles

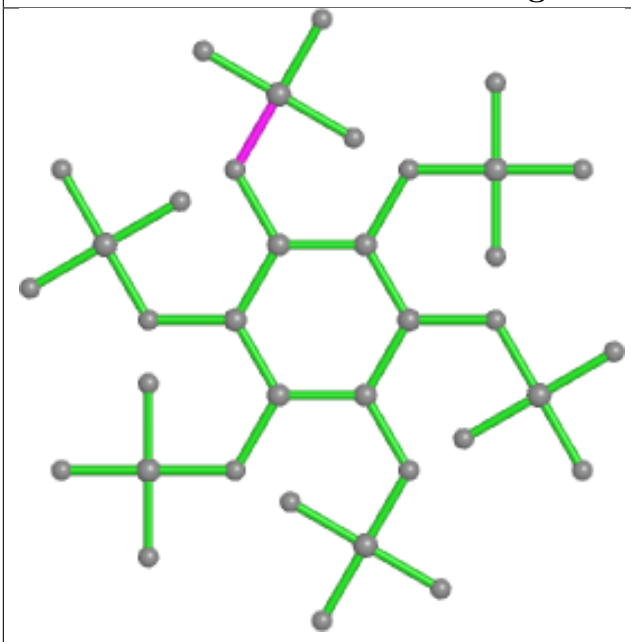


Torsions

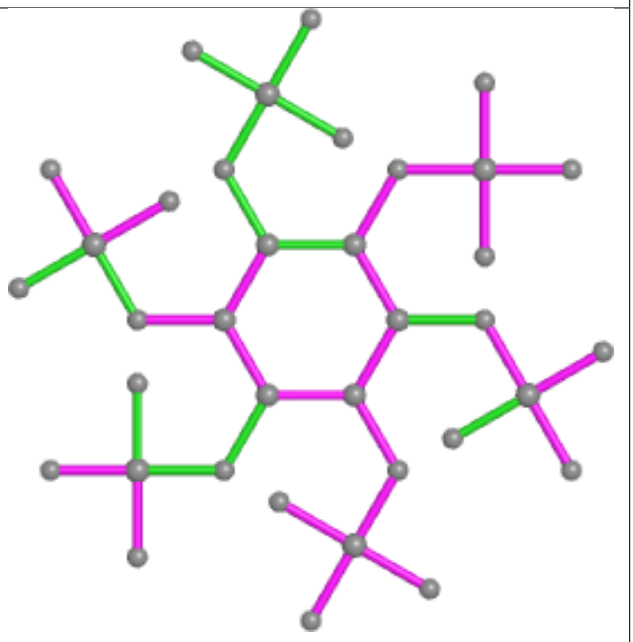


Rings

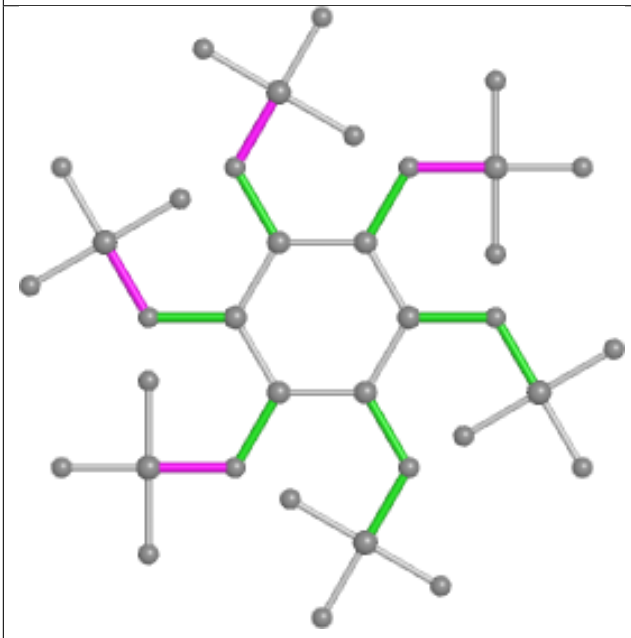
Ligand IHP A 801



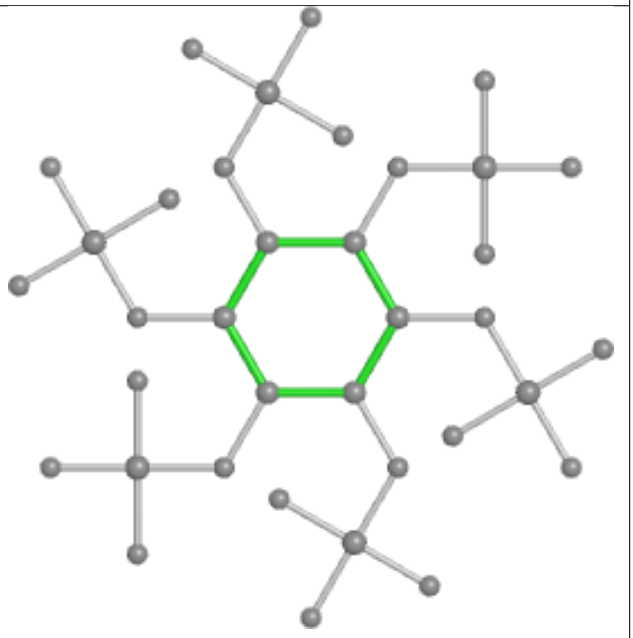
Bond lengths



Bond angles

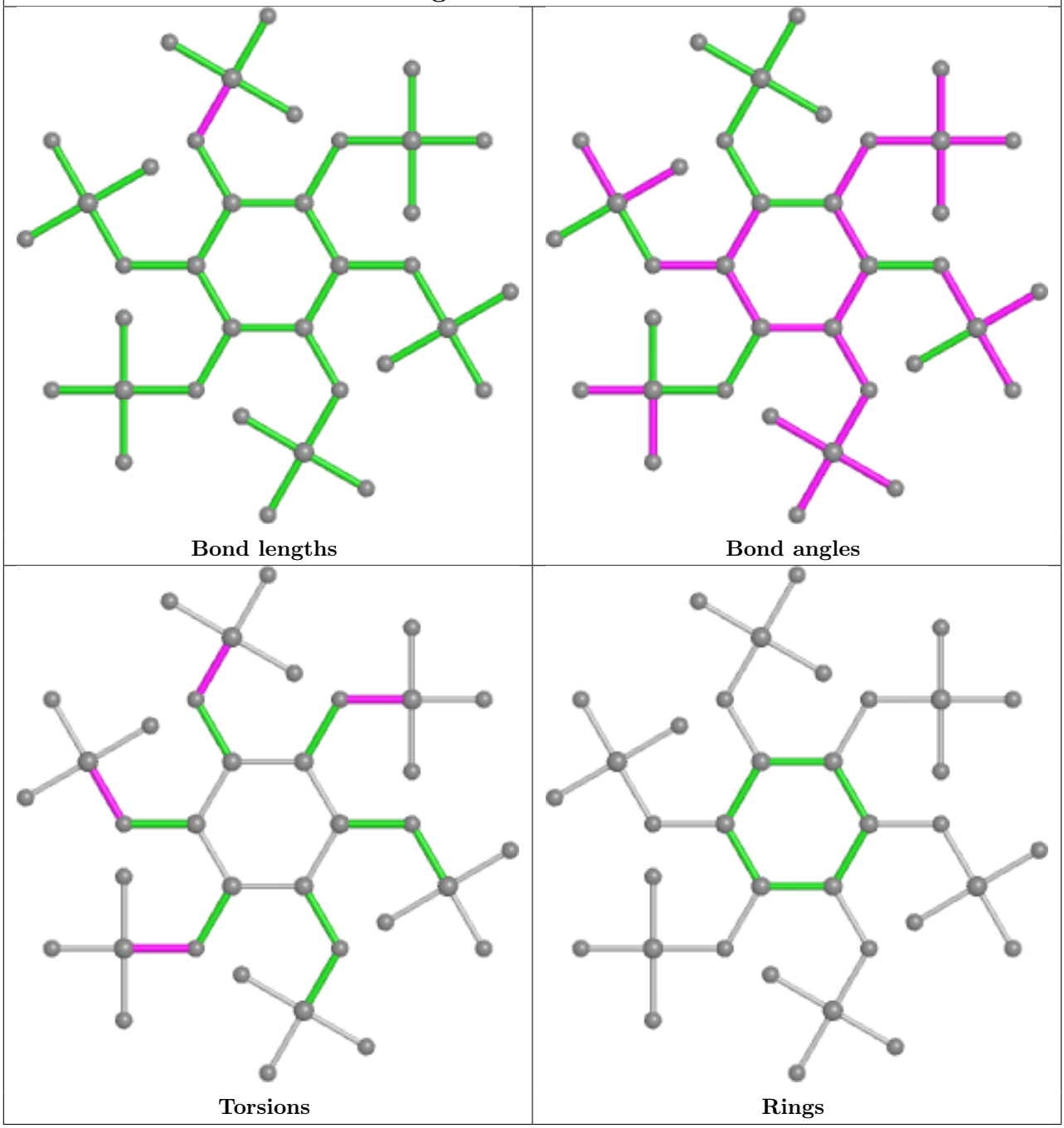


Torsions



Rings

Ligand IHP B 1002



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.