



# H&P IN-FIELD REFERENCING (IFR) SOLUTIONS

## IFR BASIN MODELS ♦ IFR PAD ♦ IFR MAX ♦ IFR 2

Reduce uncertainty & enhance drilling accuracy with the most comprehensive IFR Solution on the market

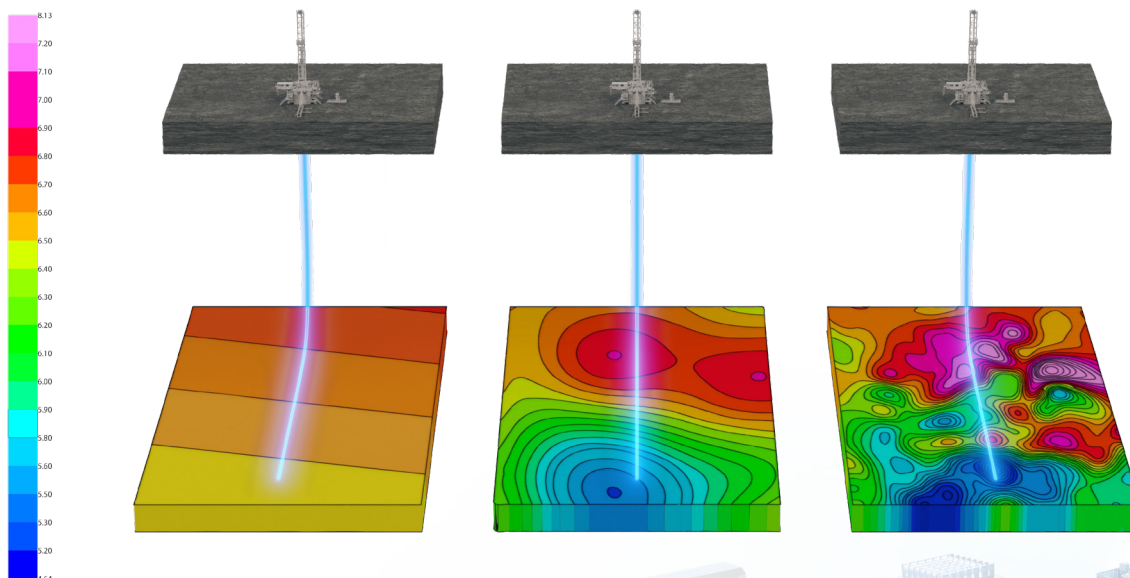
### WHY IFR?

MEASUREMENT WHILE DRILLING (MWD) SURVEYING REQUIRES A REFERENCE MODEL FOR MAGNETIC DECLINATION. GLOBAL MAGNETIC MODELS FROM SATELLITE DATA\* OFFER LOWER RESOLUTION AND HAVE HIGHER UNCERTAINTY.

With H&P's comprehensive suite of in-field referencing (IFR) solutions, operators can enhance the accuracy of their well placements and allow for an increased number of wells in a given area or pad - maximizing in-fill drilling opportunities.

IFR creates a local model of the earth's magnetic field. It maps magnetized minerals within the earth's crust and provides a high-resolution model of magnetic declination. This is necessary for accurate azimuth surveys and reduces the wellbore's ellipse of uncertainty (EOU).

When paired with our other Survey Management services, the ellipse of uncertainty (EOU) can be reduced by 60% to 80%, depending on the selected service.



## Four Offerings For A Comprehensive Solution

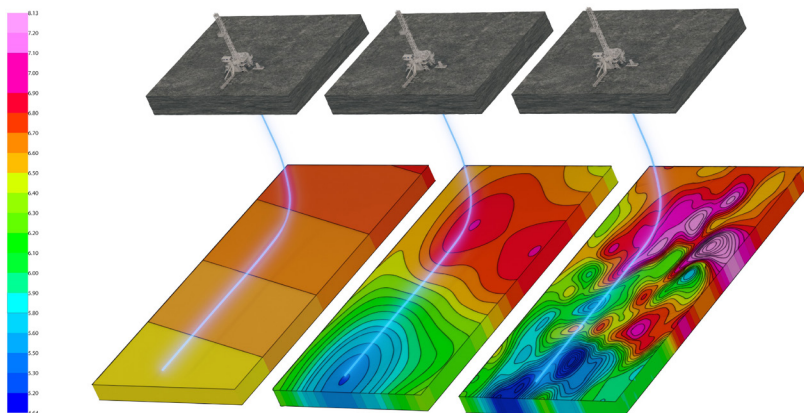
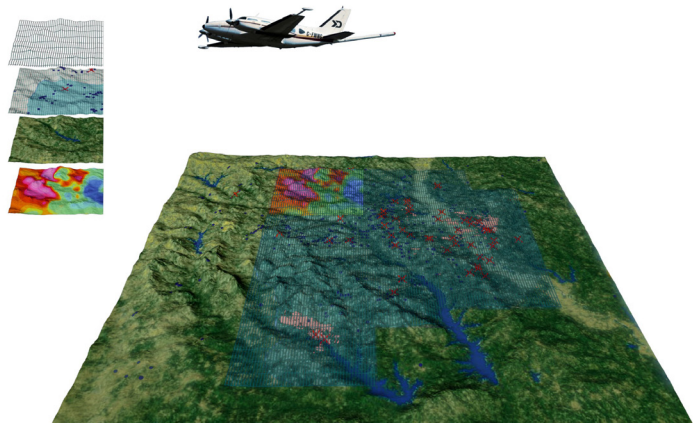
H&P's IFR offerings include IFR Basin Models, IFR Pad, IFR Max, and IFR 2, ensuring that we can meet any operator's needs to maximize reservoir contact and reduce collision concerns.

- **IFR1 Basin Models:** Basin models are ready for use at any time to provide IFR declination values, allowing operators to set up survey correction services quickly.
- **IFR1 Pad:** This service uses ground surveying over a single pad to create a model in areas lacking existing IFR model/data. It achieves a quicker turnaround time of 6 to 8 weeks compared to the months required for aircraft surveys.
- **IFR Max:** This combines an existing IFR model with ground surveying over a pad to enhance the accuracy of declination values further, effectively reducing uncertainty by 15-30% compared to IFR1.
- **IFR2\*\*:** This service measures Earth's magnetic field variations caused by solar activity. Utilizing real-time data from magnetic observatories, IFR2 corrects for these disturbances, allowing for accurate MWD surveys despite solar storms.

\*Examples of satellite data: International Geomagnetic Reference Field (IGRF), World Magnetic Model (WMM), BGS (British Geological Survey) Global Magnetic Model (BGGM), and High-Definition Geomagnetic Model (HDGM.) \*\*Available for Permian, Eagle Ford, Uinta and Marcellus

### IFR1 Basin Models:

- Aeromagnetic measurements
- Flown over a basin or play
- Map local trends
- Highly accurate
- H&P has proprietary data in the Permian Basin, Eagle Ford, Marcellus, Uinta, and Canada



### IFR Max:

- Ground surveying in the field
- Extremely accurate
- Augments existing IFR cube data
- Applicable to a single pad or several townships
- Hundreds of wells supported with this service



## Why do you need IFR?

Effective Measurement While Drilling (MWD) requires an accurate reference model for magnetic declination, as global satellite models can be less reliable. H&P's In-Field Referencing (IFR1) improves accuracy by creating localized models of the Earth's magnetic field through mapping crustal minerals, significantly reducing the Ellipse of Uncertainty (EOU). This enhances the Separation Factor (SF), allowing operators to position wellbores closer together with reduced collision risk, especially when integrated with Survey Management services. Overall, IFR1 can reduce the Ellipse of Uncertainty (EOU) leading to better well placement, precise spacing, and successful infill drilling.

## Consider a prototype well (2-mile lateral, nominally North / South):



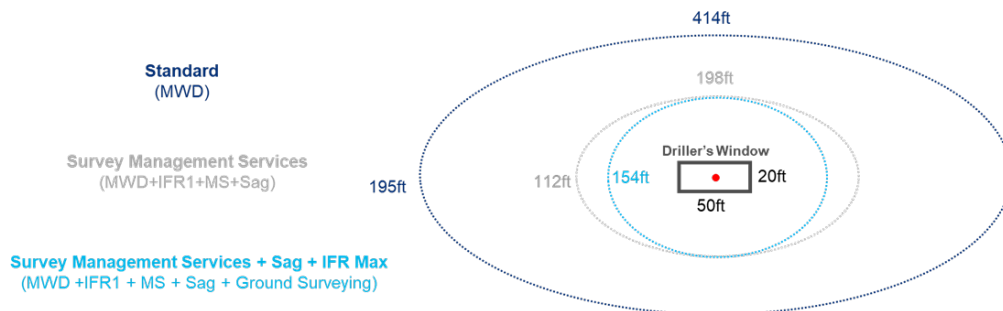
	MEASURED DEPTH (FT)
KICK-OFF	8,000
LANDING	9,125
MID-LATERAL	13,000
	17,000
TOTAL DEPTH	20,908

STANDARD (MWD)	
VERTICAL UNCERTAINTY (FT)	HORIZONTAL UNCERTAINTY (FT)
9.03	28.45
11.3	32.92
36.34	80.92
67.03	144
97.45	207.27

SURVEY MANAGEMENT SERVICES (MWD + IFR1 + MS + Sag)	
VERTICAL UNCERTAINTY (FT)	HORIZONTAL UNCERTAINTY (FT)
9.03	28.45
10.71	31.27
22.69	45.86
39.73	71.44
56.07	99.19

SURVEY MANAGEMENT SERVICES + SAG + IFR MAX (MWD + IFR1 + MS + Sag + ground surveying)	
VERTICAL UNCERTAINTY (FT)	HORIZONTAL UNCERTAINTY (FT)
9.03	28.45
10.71	30.64
22.69	39.73
39.73	57.21
56.07	77.27

LATERAL CORRECTIONS BY BASIN (10K FT LATERALS)			
BASIN	MEDIAN DISPLACEMENT (FT)	95TH PERCENTILE (FT)	99TH PERCENTILE (FT)
Canada (~700 wells)	80	380	573
Bakken (~450 wells)	24	170	249
Eagle Ford (~1000 wells)	43	212	320
Permian (~3500 wells)	40	187	307
Northeast (~450 wells)	42	154	323
Wattenberg (~750 wells)	38	192	296
Overall (~7000)	41	217	363



### Example – Uncertainty at Total Depth:

IFR Max enables another level of accuracy if you already have IFR1

**Start making data driven decisions.**  
Your wellbore is only as good as your survey.



For more information on how Helmerich & Payne can help you achieve better drilling outcomes, contact an H&P sales representative today or contact us through our website at [helmerichpayne.com/contact](https://helmerichpayne.com/contact).

**It's time to follow through on your drilling performance potential.**

Past performance is not a guarantee of future results. Any statements regarding past performance are not guarantees of future performance and actual results may differ materially.

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