State of Israel
Ministry of Energy and Water
Natural Resources Administration

Oil and Gas Unit

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Guidelines for Conducting Production Tests

These guidelines provide professional clarification of the parameters required for conducting the production tests.

According to Section 22 and 37 of the Petroleum Law, 5712-1952 the following guidelines are enclosed for performing production tests. These guidelines regulate right holders' obligation to test wells during various stages of reservoir lifecycle, and the data that the right holders must submit to the Ministry of National Infrastructure, Energy, and Water Resources.

These production test guidelines were prepared in compliance with:

*Gas Well Testing Handbook, Amanat U. Chaudhry, ISBN: 978-0-7506-7705-9 and Oil Well Testing Handbook, Amanat U. Chaudhry, ISBN: 978-0-7506-7706-6, Copyright © 2004 Elsevier Inc , Directive 017 of Alberta Energy Regulations.: Measurement Requirements for Oil and Gas Operations.**Gas Well Testing Handbook, Amanat U. Chaudhry, ISBN: 978-0-7506-7705-9 and Oil Well Testing Handbook, Amanat U. Chaudhry, ISBN: 978-0-7506-7706-6, Copyright © 2004 Elsevier Inc , Directive 017 of Alberta Energy Regulations.: Measurement Requirements for Oil and Gas Operations*

and compliant with other regulations in this area which constitute the highest standard (good industry practice).

Production tests' goals are:

1. Defining a reservoir's properties with an emphasis on exploration drills.
2. Establishing capacity for optimal exploitation of the reservoir.

There are 4 types of tests:

1. Initial static pressure test.
2. Annual static pressure test. This test must be completed by December 1 of each calendar year.

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Internet Address: www.energy.gov.il

3. Productivity test.
4. Set of analytical tests of reservoir properties (porosity, hydraulic conductivity, and so on).

The goals of production tests may vary depending on the reservoir's present development stage:

a. Exploration stage - The information obtained from the production tests must provide data that includes estimated capacities under various working regimes, pressure data, etc. The obtained data will be used to construct a model of the reservoir that is essential to defining the reservoir's physical dimensions.
b. Development stage - production tests reduce uncertainty and improve quality of the reservoir model. Test results at the development stage can make a difference to the number and location of production wells and confirmation wells that are required.
c. Commercial production stage - The production tests make it possible to revise the models and update work regimes in producing wells accordingly, as well as updating the reservoir's exploitation coefficient.

The document enclosed below describes several methods of production testing during exploration, development, and commercial production stages of conventional petroleum and gas reservoirs and non-conventional ones such as shale oil, petroleum and gas shale, etc.
The document contains several forms that the right holder must use when submitting production test results to the Petroleum Commissioner, as required by good industry practice standards.

Right holders are required to conduct these production tests, compliant with these guidelines from the day the guidelines are published.

TO: OIL&GAS INDUSTRY.

SUBJECT :WELL TESTING GUIDELINES

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Introduction:

Vocabulary

Reservoir pressure is fluid pressure inside formation pores**.**

Initial pressure is original, undisturbed static bottomhole pressure of a reservoir prior to fluid production (after short pre-flow clean–up period).

Abandonment pressure is pressure at which commercial recovery is not longer feasible from formation.

Flowing bottomhole pressure is pressure determined at the formation face of reservoir while fluid flow from reservoir.

Static bottomhole pressure is formation pressure measured at prevailed static condition of reservoir achieved by shutting of the well for considerable period.

Absolute open flow (AOF) is the maximum rate at which a well could flow against a theoretical atmospheric backpressure at the sandface. *AOF will be used to allocate allowable production among wells or to set maximum production rates for individual wells*.

Inflow performance (IP/IPR) is the graph describes the relationship between surface production rate and BHFP (bottom hole flowing pressure) either the original pressure or the current average value. *The IPR curve is used to evaluate well current deliverability potential under a variety of surface conditions, such as production against a fixed backpressure. In addition, the IPR can be used to forecast future production at any stage in the reservoir's life.*

Built up test –pressure measurement after the well is shut for a specified period, and a bottom-hole pressure gauge is run to record pressure.

Fall-off test - pressure measurement and analysis taken after an injection well is shut in. These data are often the easiest transient well-test data to obtain.

Drawdown test are production flow test conducted on producing well with measurement of flow rates and bottomhole pressure.

Flow-after-flow tests are production flow test conducted on producing well at a series of different stabilized flow rates and measuring the stabilized BHP (bottom hole pressure). Each flow rate is established in succession without an intermediate shut-in period.

Single-point test is conducted by flowing the well at a single rate until the BHFP is stabilized. This type of test was developed to overcome the limitation of long testing times required to reach stabilization at each rate in the flow-after-flow test.

An isochronal test if production flow test which consists of a series of single-point tests usually conducted by alternately producing at a slowly declining sandface rate without pressure stabilization and then shutting in and allowing the well to build average reservoir pressure before the next flow period. **Modified isochronal test** is similar, except the flow periods are of equal duration and the shut-in periods are of equal duration (but not necessarily the same as the flow periods). *Isochronal and modified isochronal tests are developed to shorten tests times for wells that need long times to stabilize.*

Well testing is recording formation pressure dynamic and production rate to determine the presence of petroleum, to complete evaluation of well productivity & predicts production system performance and reservoir characterization, and , also, potential commercial value in terms of abundance and accessibility, Testing produces through open or cased well hole on packer lowered on drill pipe or tubing.

Wireline formation testing (mini well test) is test on a zonde positioned at selected depths in the formation to provide accurate measurements of pressure and fluid type within very short time, so, could be used primary to define fluid types, HWC and very preliminary reservoir characteristics.

Annually pressure test is definition of bottomhole static pressure annually.

Production flow test is long dynaic bottomhole pressure and production test for definition of production deliverability of the wells by finding optimal correspondence of well head and formation pressures and equipment.

Pressure transient test – combination of shut-in and flowing periods of the well with measuring of dynamic bottomhole pressure and production rate (for flowing part) for understanding of productivity of the well, formation parameters evaluation.

Bubble Point Pressure - defined as the pressure at which the oil is saturated with gas. Above this pressure the oil is undersaturated, and the oil acts as a single phase liquid. At and below this pressure the oil is saturated, and any lowering of the pressure causes gas to be liberated resulting in two phase flow.

Production logging test - record of one or more in-situ measurements that describe the nature and behavior of fluids in or around the borehole during production or injection. Production logs are run for the purpose of analyzing dynamic well performance and the productivity or injectivity of different zones, diagnosing problem wells, or monitoring the results of a stimulation or completion.

The term is sometimes extended to include logs run to measure the physical condition of the well, for example cement bond and corrosion logs.

Choke - an element of restriction which is commonly installed in wells or production operations to control pressure and flow rate. The size of a choke is referred to its diameter size.

Deliverability - oil or gas production rate achievable from reservoir at a given bottom-hole pressure.

Wellbore volume - volume of HC from tested interval calculated with drainage radius

Concurrent production - simultaneous production from 2 layers, example, gas cap and main oil reservoir.

General comments and requirements

- Present document states rules and schedule to apply wells tests and to provide MNIEWR with data and result of wells tests interpretation.
- Many classifications of the tests used but here was chosen one based on application of the results of the tests:
    - Initial pressure test which should be done at any new wells without exemptions.
    - Annual static pressure test, schedule and rules of application below.
    - Production flow test, schedule and rules of application below.
    - Transient pressure test, schedule and rules of application below.
- Any hydrocarbons discovery could be confirmed only by based on longer Pressure transient test which could fully prove commercial effectiveness of future production. Without such test, full raw data set and data interpretation, discovery could not be approved.
- Any well test should be described into well test proposal:
    - Well permit holder must ensure that proposal for well test submitted to MNIEWR min 30 days before the operation. MNIEWR has right to revoke the well test proposal, to request to change conditions and the test could not be implemented till written permitting of MNIEWR would be received.
    - Initial well tests should be specified at Drilling program and when the rig reaches Total Depth and all the available data is analyzed, the Well permit holder should provide MNIEWR with detailed well test proposal.
    - Well test proposal should fully describe formations at intervals to be tested and planned operations:
        - description of formation characteristics: expected level of petrophysical properties, including but not limited by conventional volumetric properties, permeability, fractures presence and mechanical characteristic, lithological description, fluids types, formation pressure and temperature etc.
        - description of planned operation: types of test, required equipment, QSHE requirements, well test pressure regimes, flowing or sampling test, duration of test, type of completion fluid, type and density of fluid against which the well will be opened, type of perforating gun and number of shots per foot, use of coiled tubing stimulation, etc.
- Wells test raw data and report
    - All set of raw data got in process of Well test must be submitted to the MNIEWR office within 30 days (if different would not be specified below) of the completion of the test; Reservoir Pressure Survey Test (PST) Report which should be accompanied by

filled forms listed below should be provided to MNIEWR within 60 days of the completion of the test.

  - Complete Service company interpretation report should be delivered within max 90 days after finalization of well test. Interpretation report should include full description of approaches used, formulas, assumptions etc. Without methodology of interpretation description, the report will not be accepted.
  - If based on the Test report and associated data, MNIEWR recognized well test's result as insufficient, the test may be deemed invalid and additional testing ordered.

- Well permit holder must ensure what wells tests will be done in accordance the rules and schedule described below, also, MNIEWR has right to request additional wells tests in case of special cases described below.
- Formation pressure should be reported when pressure stabilization achieved. In high permeability reservoirs or wells with small drainage areas, it is possible to flow the well until stabilization during the extended flow period of the test. For most purposes, a "stabilized reservoir pressure" is defined as a pressure that does not build over 290 PSI/hour during a 6 hour period. In general, stabilized reservoir pressure can be obtained within a 14-day shut-in period (using built-up or static pressure measurements).
- In low permeability reservoir, it could take more than 14 days to achieve pressure stabilization and then measured or extrapolated pressure which at least 95 percent of the fully built-up pressure is considered adequate. Special technics of wells tests should be applied at low permeability formations. Duration of well test could not exceed 6 month. Transient pressure test should be done at low permeability formation to model reservoir's properties. Interpretation of stabilized flow rates is required with possible exemption for tight reservoirs:
  - Many tests in tight reservoirs, are not flowed to stabilization because of time constraints. An extended flow and stabilized shut-in are still performed at the end of these tests so that the buildup data can be analyzed and from that the stabilized rate calculated. Stabilized flow can be determined by calculation or by creating a model of the reservoir, doing a forecast at a specified pressure, and finding the point when the rate has stabilized (usually at 3 months, 6 months, or 1 year) . Description of the modeling and the result should be included in well test report.
- Low permeability reservoirs (lower 10mD for oil and lower 1mD for gas reservoirs) should be tested prior and after application of technologies for increase of productivity. Productivity index and other parameters of the well should be analyzed before and after the treatment. The program of the treatment should be applied together with Well test proposal.
- Preferred and accepted at most of the cases method of determining formation pressure (especially static formation pressure) is with a bottom-hole recorder. Only at some cases and only at one phase flow and high permeability reservoir (average permeability is higher than 200 mD), calculation of bottom pressure based on wellhead pressures measurement could be allowed by MNIEWR after investigation of well test proposal.
- For any fields, accurate core analysis, log data, field data (to check homogeneity, porosity/permeability model and magnitudes, OWC/GWC etc.) from target zone and upper and lower sections should be presented.

A. Target objectives to interpretation of various type of wells test with requirements of MNIEWR

Well test class	Parameters to define	Exploration[1]/Appraisal well		Development well		Producing, shut-in or injection well to improve performance	
		Openhole WL[2] RFT/ MDT/RCI)	DST	WL	Bottomhole gauge	PLT	Bottomhole Gauge
Initial pressure test	Pressure-Depth profile	RT		RE			
	Reservoir fluid density from gradient	RT		RE			
	Reservoir fluid contact	RT		RE			
	Initial downhole pressure	RT	RT	*RT*[3]	*RT*		
	Drawdown and built-up mobility, permeability	RT		RE			
	Anizotropic permeability determination	RT		RE			
Pressure transient test	Reservoir deliverability, KH/m		RT		RT		RE
	Skin factor		RT		RT		RE
	Reservoir heterogeneities and flow model		RT		RE		RE
	Drainage radius		RT		RT		RE
	Reservoir boundaries		RT		RT		RE
	Horizontal interference test				RE		RE
	Vertical interference test, Multilayer test				RE		RE
Annual pressure well test	Annual downhole pressure						RT
Production flow test	Average reservoir pressure					RT	RT
	PI /IPR, AOF, VFP		RT		RT	RT	RT
	Treatment efficiency						RT
	Technical circumstance of the well					RT	
	Injection well test						RT
	Wellbore fluid contact					RT	

[1]Discovery could be accepted only based on well test which confirm economical efficiency.
[2] Initial pressure and formation characteristic could be accepted from such test at high permeability formation.
3 Cursive marks two concurrent types of the test/type of the well. Only one could be applied.

	Vertical fluid flow patterns					**RT**	
Production flow test or initial test	**Fluid samples**	**RT**	**RT**	**RT**	**RE**		**RT**
	Representative fluid samples		**RT**		**RE if not done previously**		

RT – required in accordance with the rules below. RE - recommended with exemptions of Special Cases. **RE** (bold) – could be strict requirement at Special wells/Chosen Wells, Section E. WL – WireLine logging. PLT – Production logging, required when it is applicable at Special cases described at Section D of the Guidelines for conducting well tests.

B. Initial Pressure Testing Requirements

Initial subsurface static pressures **are required on productive oil and gas wells as follows**:

Oil and gas Wells – on all productive exploratory, discovery, development wells within the first month of production prior to any sales or production.
Exemptions are impossible. In case of any waiver of initial pressure test, official request should be sent and should be accompanied with detail explanation of the reason of waiver. Test could not be done only in case of official permission coming from MNIEWR.

Initial Pressure could be valid from Logs - Reservoir Pressure Survey Test (RST/MDT/RCI etc), DST or DFIT test (Fall-off injection test for fractured formation) may meet the initial pressure testing requirement.

C. Annual Pressure Survey Requirements

Annual static pressure surveys must be conducted on oil and gas reservoirs, as specified in the Annual survey schedules:

- Survey 25 per cent of the producing wells count in oil and gas reservoirs/field but not less than 2 wells per productive layer and segment limited by not transparent faults or other types of seals.
- Survey 25 per cent of injection well count in oil and gas reservoirs/field but not less than 2 wells per productive layer and segment limited by faults or other types of seals.
- In case of the field contains 3 wells or less, annual pressure test should be done min on 1 well per productive layer and segment limited by not transparent faults or other types of seals each of the year.

For some cases MNIEWR could consider exemptions of the tests in case of special request from License holder and it is possible to be considered only if case:

- Initial static well pressure was defined properly and formation pressure stabilization was proved while the test.
- Production data from each well measured and reported from individual well manifold installed on WH (not back allocated) and pressure data measured from bottomhole gauge and on well head as well as described at item H;
- The layer performs only one flow (one fluid).
- Difference between plan-fact production and pressure data within a month do not deviated more than on 10%.

Any exemptions are impossible if License holder would not report calculated static pressure and all data in accordance with item H.

The well with heavy oil (usually with density higher than 925 kg/m3 at 15 grad C) could be exempted from annual test if daily report of production data in accordance with item H is absent.

Minimum requirement to Initial and Annually pressure tests.

- Well permit holder must provide MNIEWR with all recorded data (gauge depth, static bottom hole pressures from gauge, duration of the resulting shut-in period etc) and form A within 60 days, for MiniDST also should be pressure array with DEPTH, Hydrostatic pressure (before and after) in digital Excel format, filled Form A within 30 days after the date on which the pressures were measured.
- Well permit holder must ensure that the initial static bottom hole pressure of each completed zone of each of the permit holder's oil or gas wells is measured before any significant production or depletion of the reservoir occurs.
- Taking the initial pressure after a reasonable cleanup flow period is acceptable providing the test shows that a stabilized reservoir pressure has been reached.
- Annual pressure only after surveyed wells remain shut-in until the reservoir pressure has been attained in the well bore or until sufficient data are available to permit the calculation of the reservoir pressure and, in the latter case, details of the reservoir pressure calculations are included in the report.
- Service company interpretation reports should be presented to MNIEWR within 90 days of the completion of the test.
- The tests should always be done after preliminary Clean-up.

Form A of the report for Sections B and C

Form must be submitted at the address noted below and accompanied by the all test data and analysis provided by service company and operator.

WELL INFORMATION	
Well Name:	Well Permit No.:
BH Location:	Kelly Bushing Elevation ____ ____ ____ m
Field: Reservoir:	C.F. ____ ____ ____ m
Completion Interval: ____ ____ ____ m	Mid-point of Completion: ____ ____ ____ m
Well Type: vertical ☐ directional ☐ horizontal ☐	Fluid Type: gas ☐ oil ☐ water ☐

TEST DATA	
Test Date (yyyy/mm/dd):	Temperature and density @ Run Depth
Shut-in days (to the nearest single decimal):	Temperature ____ ____ ____ °C
Liquid Level in Wellbore: m ***(TVD)***	Mud density ____ ____ ____ g/cm3
Type of the test (type of tests, gauge, stabilization period, special circumstances or details):	
Wellbore Gradient @ Run Depth (to three decimal places) ____ ____ . ____ ____ ____ psi/ft	Formation Gradient (to three decimal places) ____ ____ . ____ ____ ____ psi/ft
Reservoir Pressure	**Last Measured Pressure**
Static Pressure: _____ PSI g ☐ a ☐ At a Run Depth of: _____ m ***(TVD)*** ____ ____ ____ ☐ extrapolated pressure P*or ____ ____ ____ ☐ calculated average reservoir pressure Pr	Last Measured Pressure: _____ PSI g ☐ a ☐ At Run Depth of: _____ m ***(TVD)*** Pressure Building @ _____ PSI/hr (** reported for built-up and fall-off pressure tests only)
Comments:	

COMPANY INFORMATION		
Completed by:		Company:
Date:	Phone:	Email:

Instructions (applicable for all the forms below):

Gauges

Information of used gauges should include following details:

A. How pressure reading at wellhead matches to pressure calculated from independent dead weight reading;
B. most recent calibration;
C. highest bottom-hole reading;
D. less records with anomalous behavior.

Deviated Wells

Tests on directional and horizontal wells are problematic in correcting pressures to a common reservoir datum. Every effort should be made to report the run depth corrected to the true vertical depth (TVD) referenced from the CF. Where this is not possible, the operator must indicate that the run depth is referenced as measured depth (MD) by checking the appropriate box.

Gradients

Where the fluid in the wellbore differs from that expected from the pay zone of the formation, both the wellbore and formation gradient must be noted. A common example would be a gas well in which a static gradient test encounters a bottom-hole water leg. The form contains a box to note any liquid level indicated in the wellbore.

Built-up or fall-off tests

The test date is the date of the last recorded pressure. For built-up or fall-off tests, MNIEWR need records not only the extrapolated pressure and averaged pressure at stable reservoir conditions but , also, last measured pressure. The extrapolated pressure and averaged pressure must be averaged for the drainage area. Care must be taken when reporting the P* or Pr value; they must be reported at the recorder run depth, not corrected to a well datum.

D. Production flow Testing

The purpose of these tests is to predict the manner in which the flow rate will decline with reservoir depletion. The flow capacity must be determined for different backpressures or flowing bottom-hole pressures at early stage of the well (reservoir exploitation) and, in case significant difference between planned and fact earlier predicted production & reservoir pressure and other characteristic at any stage of the field life. The purpose of these tests is to determine optimum rate at which well can flow at surface/equipment/pressure/reservoir condition at any stage of the field based on:

- Deliverability equation;
- Identify produced fluids and determine their respective volume ratios

  - Absolute Open Flow (AOF) potential of a well is defined as the rate at which the well will produce against a zero backpressure;
  - Productivity index (PI);
- Inflow performance curve.
- characterize formation damage and other sources of skin
- measure reservoir pressure and temperature
- obtain representative fluid samples suitable for PVT analysis
- evaluate completion efficiency
- evaluate workover or stimulation treatments

Production flow test is obliged test for permit holders for:

- All oil and gas wells within min first 3 months of production formation.
- Special cases: chosen oil or gas wells in case of water flow increase; for oil well in case of gas flow increase suddenly or for fields which reached certain recovery factor (50% at high porosity conventional reservoirs). Well candidates could be producing, shut-in, injections wells, also, different horizon than presently producing. The choice should be proved to MNIEWR at well test proposal.

Minimum requirement:

General:

1. All data from Production flow tests conducted must be submitted in the EXCEL and the result of interpretation in the Form below.
2. The tests should always be done after preliminary Clean-up.
3. At least one of the flow durations must be long enough to investigate reservoir properties.
4. In case of planning to use well stimulation treatment, 2 deliverability tests should be made before and after the treatment. In general, well stimulation required for the wells with average permeability lower than 10mD for oil reservoir and 1md for gas reservoir required and should be presented at Well test proposal. For such reservoir Transient well test should be applied to build reservoir models.
5. All pressure from oil wells with 2-3 phases flow should be reported from bottomhole gauge only.
6. In general, in-Situ GOR measurement procedure should be installed for oil wells with 2-3 phases.
7. The constant productivity index concept is only appropriate for gas and oil wells producing under single-phase flow conditions, pressures above the reservoir fluid's bubble point pressure. For oil reservoir pressures less or around than the bubble point pressure, the reservoir fluid exists as two phases, vapor and liquid, and techniques other than the productivity index must be applied to predict oil well performance.

Reservoirs with Enhanced Recovery

- Well test proposal should include production analysis, illustration of the area with maximum production potential, proposal for implementation of methods of enhanced recovery and recovery factor and recoverable reserves volume technically and economically.
- Shut-in wells, within the producing area of a reservoir, may be good candidates for pressure observation and could be required and requested by MNIEWR.
- Test on injection wells could be required and requested by MNIEWR .

Calculation of bottomhole pressure from well head pressure

- Test includes determination of bottomhole pressures with a bottomhole pressure gauge. For some cases MNIEWR could allow estimations of reservoir pressure from wellhead pressure measurements. It should be described at Well test Proposal presented to MNIEWR together with characterization of methods of measurement, gauge and it metrological and quality status. The decision about allowance to use wellhead data gathering will be taken by MNIEWR at each individual case.
- In case of request of exemptions to use wellhead gauge, the method of calculation of bottomhole pressures should be presented to MNIEWR at Well test Proposal and later on confirmed at Well test Interpretation report.
- gauge pressure rating should be matched to expected flowing and reservoir pressure
    - a high pressure gauge in a low pressure reservoir may cause stair stepping and introduce noise affecting derivatives used in test interpretation
    - a low pressure gauge in a high pressure reservoir will compromise the mechanical integrity of the gauge.

Special circumstance:

Possible reasons for special Production flow Well tests request listed below:

Oil reservoirs

- enhanced recovery,
- good production practice,
- concurrent production,
- partial reservoir requirement
- special areal coverage requirement,
- specific wells that require monitoring,
- observation wells .

Gas reservoirs

- off target wells
- acid gas disposal wells
- gas cycling schemes
- gas storage wells
- observation wells

Other considerations when designing a Production flow test:

- expected H2S percentage/maximum release rates,
- flare dispersion modelling (flare stack design and cumulative assessment),
- flare efficiency (if flaring),
- reservoir properties,
- flow rates, restrictions and duration of flow (higher rates do not necessarily increase the radius of investigation),
- turbulence effects,
- wellbore configuration (hydrate range, liquid loading, clean-up needs, etc.),
- type of stimulation,
- fluid analysis needs,
- coning/drawdown limitations,
- test equipment sizing,

- wellbore storage (downhole shut-in tool),
- interference effects/other producers in the area

Form B of the report for section D

WELL INFORMATION	
Well Name:	Well Permit No.:
BH Location:	Kelly Bushing Elevation m
Field: Reservoir:	Casing Flange Elevation m
Completion Interval: - m	Mid-point of: m
Well Type: vertical ☐ directional ☐ horizontal ☐	Fluid Type: gas ☐ oil ☐ water ☐

TEST DATA						
Test Type:	SP ☐	MP ☐	FPMI ☐	FAF ☐	CU ☐	UBD ☐ OTHER _____ ☐
Final date of test flow: (yyyy/mm/dd)				Gas produced to:	flare ☐	pipeline ☐

Total Test Volume(s) Produced:	Net Gas (103m3)	Condensate (m3)	Oil (m3)	Water (m3)

Rate	Duration (hrs)	Net Gas Rate ($10^3m^3/d$)	Net Oil Rate ($10^3m^3/d$)	Cond. Rate (m^3/d)	Water Rate (m^3/d)	Shut-in Pressure (BH, PSI(a))	Final Flow Pressure (BH, PSI(a))
Under-Balanced Drilling						—	—
Clean-Up						—	—
1							
2							
3							
Extended							

Stabilized Rate Absolute Open Flow Potential (AOF) DATA				
	Extended Rate Absolute Open Flow Potential (AOF)	Stabilized Rate Absolute Open Flow Potential (AOF)	Reciprocal Slope of Gas Rate/ Pressure Squared Plot (n)	Assumed "n"?
Sandface:				yes ☐ no ☐

Wellhead:				yes ☐ no ☐
Reservoir Pressure (PSIa):			Skin Value:	

Comments: .....

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NOTE: Test types other than CU & UBD require the filing of a Reservoir Pressure Survey Test (PST) Report.

COMPANY INFORMATION		
Completed By:		Company:
Date:	Phone:	Email:

Instructions (applicable for all the forms below):

Test Type

Indicate the appropriate test type by selecting the corresponding check box. Where the sole purpose of the test is a well clean-up resulting in burnable gas to the surface, select "CU" as the test type and enter the applicable rate and volume data. However, if a clean-up period is carried out in conjunction with a subsequent Production flow test, select the test type corresponding to the Production flow test and include the clean-up flow rate and production volumes on the same form with the test data.

Under-Balanced Drilling

This form is to be submitted for under-balanced drilling operations that result in burnable gas to surface. Reported test type should be "UBD". Flared gas volumes reported are to be the **net** volume produced by the target formation (gas produced *minus* gas injected). Net gas rates should be representative of the burnable gas produced near the end of the UBD operations with the duration being the cumulative time that flaring occurs. A copy of the field notes recorded during drilling must be provided with this report.

AOF and n Value

The sandface and wellhead AOF values should be calculated at both extended and stabilized conditions. For low productivity wells with test rates less than 20 e3m3/d, the calculation of only wellhead AOF values is permitted. Complete details of all AOF calculations must be included with the test submission as "n" value s derived from the Simplified Analysis technique. Where the value of "n" is derived from the test data, the assumed flag should be checked as "no". Single point

tests are normally checked as assumed “yes”, unless the “n” is derived from an earlier test on the well under similar wellbore and reservoir conditions. Low productivity wells normally have an n value of 1.00.

Pressures

Pressure data is reported for all test types other than “CU” or “UBD”. The “Shut-in Pressure” is defined as the bottomhole pressure as measured prior to each flow rate. The “Final Flow Pressure” is the bottomhole pressure as measured at the end of that flow period. The stabilized reservoir pressure is entered on the form under “Reservoir Pressure”. Pressure is to be reported in absolute, to the nearest PSI. MNIEWR acceptes correction factor for gauge to absolute is 101 PSI.

Comments

Note remarks pertinent to the well or specific test. Please indicate any information that would help in interpreting the test data or in designing future tests on the well. Examples:

- Insufficient shut-in time.
- Following AOF test.
- Interference evident during built-up.
- Obstruction in tubing, unable to reach MPP.

Please use the “Comments” section to make remarks pertinent to the well or specific test, indicating any information that would help in interpreting the test data or in designing future tests on the well. Examples:

- Following frac and acid squeeze.
- Slugging water throughout test.
- No bottom-hole gauges run.
- Predict stabilized conditions in 3 months.
- Well suspended past 12 years.

Abbreviations/Acronyms

- MPP - Mid-Point of Perforations/Completion
- SP - Single-Point
- MP Multi-Point
- FPMI - Four-Point Modified Isocronal
- FAF - Flow After Flow
- UBD - underballance drilling

E. Transient pressure test

Transient pressure test presented as separate test just for specification of expected result of the test, it is doing together with other tests and consists of series of flowing wellbore pressure and production measurement as a function of time (drawdown test) and followed by built-up test.

Transient pressure test dedicated to definition of major reservoir characteristics:

- Determine well deliverability

- Average reservoir pressure.
- Shape, geometry, extent of the reservoir, reservoir discontinuity, drainage area.
- Flow capacity and productivity.
- Skin factor, Wellbore volume, damage, and improvement.
- Evaluate reservoir parameters. Permeability and porosity types.
- Determine hydraulic communication between wells
- Characterize reservoir heterogeneities.
- Monitor well performance in competitive drainage situations.
- Track productivity to ensure proper production allocation.
- Create analytical and numerical production models (single-zone vertical to multi-frac horizontal wells).
- Determine stimulated reservoir volume, optimal well spacing and EUR/well for unconventional reservoirs
- Prove discovery especially obliged at unconventionally reservoir like low porosity/permeability reservoir, high heterogeneous reservoir etc.

In general, pressure transient tests consist of drawdown and build-up periods:

- Pressure drawdown tests are performed after the well has been shut in for a period sufficient to establish static pressure conditions. The well is opened and produced at a steady flow rate while the pressure change is observed at the gauge. Flow rates at surface are recorded at regular time intervals during the test. For gas wells with sufficient flow rate, several flow periods (at least three) are required. Also for high rate oil wells several flow periods are recommended.
- Pressure built-up tests are performed after the well has flowed for a period sufficient to establish a radial flow regime. The well is closed while the pressure change is observed at the gauge. The duration of the build-up should be long enough to establish the test objectives.

Transient pressure test is obliged test for permit holders for:

- All exploration and appraisal oil and gas wells on min 1 well per formation/field limited by sealed faults or other kind of sealing (1 well is allowed only in case of clean homogenous sandstone reservoir with very high porosity and permeability, for more difficult cases decision will be taken individually while discussion of Permit Holders with MNIEWR)/reservoir). Homogeniusty of the reservoir should be proved by core and logs data from min 2 wells drilled at different side of the field.
- Special cases: Chosen development wells or producing wells on recompletion stage if properties of reservoir were not defined and reported properly on earlier stage on min 1 well (1 well is allowed in case of clean homogenous sandstone reservoir with very high porosity and permeability and provided absence on vertical and horizontal barriers; for more difficult cases decision will be taken individually while discussion of Permit Holders with MNIEWR)/reservoir).

PTA in exploration wells could not be the case of exemption.

All requests for exemption of PTA on development or producing well will be considered by MNIEWR only in the case of full coverage of target zones and beyond reservoirs on this particular well by logs and core (RCA and SCAL) and RCI/MDT data supplied to MNIEWR with associated analysis and interpretation reports which could describe properties of the reservoirs and beyond and, also, if those data together with seismic data demonstrate reservoir model, homogeneity of reservoir, absence any kind of barriers and if there is no questions to deliverability of the well, to borehole,

interconnections between the wells etc. If not – execution of full PTA test is strict requirements.

Minimum requirement:

- All raw data from the tests conducted must be submitted in the EXCEL.
    - raw pressure data
    - all types curves which are , in general, preplotted solutions/models, like log-log diagnostic plot, the extrapolation plot or pressure history matching plot etc
    - a statements regarding the analysts of confidence level of the results
    - all tried and final reservoir models, assumptions and equations and side data used for the calculations. For the reservoirs with suspicions of double porosity and/or permeability, it should be modeled and conclusions should be provided.
- Testing should always be should be done after Clean-up.
- For most purposes, a “stabilized reservoir pressure” is defined as a pressure that does not build over 290 PSI/hour during a 6 hour period.
- In case of planning to use well stimulation treatment, 2 tests should be made before and after the treatment. In general, well stimulation required for the wells with average permeability lower than 10mD required and should be presented at Well test proposal.
- The tests should be done with bottomhole gauge only.

Form C of the report for section E

WELL INFORMATION	
Well Name: BH Location:	Well Permit No.:
Field: Stratigraphy:	Kelly Bushing Elevation m
Mud density____ ____ ____ g/cm3 Mud density ____ ____ ____ g/cm3 :	Casing Flange Elevation m Borehole radius, ft
Lithology:	Bottom hole, m:
Average porosity and permeability, logs/core %:	Clean-up, methods and fluid:
Perforation Interval, m _____ Perforation type, m _____	Mid-point of: m
Well Type: vertical ☐ directional ☐ horizontal ☐	Fluid Type: gas ☐ oil ☐ water ☐

TEST DATA				
Test Type: SP ☐ MP ☐ FPMI ☐ FAF ☐ CU ☐ UBD ☐ OTHER _____ ☐				
Final date of test flow: (yyyy/mm/dd)		Gas produced to: flare ☐ pipeline ☐		
Total Test Volume(s)/run/duration (s) Produced:	Net Gas (103m3)	Condensate (m3)	Oil (m3)	Water (m3)

TEST DATA	
Number of Drawdown, Drawdown duration:	Temperature and density @ Run Depth
Number of Shut-in, shut-in duration:	Temperature____ ____ ____ °C
Liquid Level in Wellbore: ____ ____ ____ m ***(TVD)***	Fluid formation factor ____ ____ ____ rb/STB Fluid viscosity ____ ____ ____ cp
Wellbore Gradient @ Run Depth (to three decimal places) ____ ____ . ____ ____ ____ psi/ft	Formation Gradient (to three decimal places) ____ ____ . ____ ____ ____ psi/ft

TEST RESULT	
Static Pressure: _____ PSI g ☐ a ☐ At a Run Depth of: _____ m *(TVD)* • ☐ extrapolated pressure or • ☐ calculated average reservoir pressure	Last Measured Pressure: _____ PSI g ☐ a ☐ At Run Depth of: _____ m ***(TVD)*** Pressure Building at _____ PSI/hr (** reported for built-up and fall-off pressure tests only)
Generalized Skin:	Drainage radius, m

Skin while changed well bore zone: Skin in well imperfection due to partial penetration:	Productivity index, m3/day Mpa
Pressure productivity factor, cm2/sec	Permeability, mD

Date	**Choke diameter, mm**	**Duration, hours**	**Pressure**			**Depression, psi**	**Temperature , C**	**Rate, m3/day**
			Casing pressure, psi	**Tubing pressure, psi**	**Bottomhole, psi**			

Comments and Conclusion: .....

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NOTE: Test types other than CU & UBD require the filing of a Reservoir Pressure Survey Test (PST) Report.

COMPANY INFORMATION		
Completed By:		Company:
Date:	Phone:	Email:

F. Fluid Analyses

- All fluid analyses conducted on samples gathered previously at wells which are representative of the formation (not mixed stream), must be submitted to MNIEWR.
- Further, gas and/or fluid analyses are required in:
  - Sampling and fluid analysis is required at each of target horizon of the field min from 1 well for homogenous, not split by faults reservoir.
  - MNIEWR could request additional fluid sampling and analysis.
- The well should be flowing in a stable state, with correspondingly stable separator readings for at least 6 hours before the start of any sampling. The stability of the well may be determined by:
  - Gas and Oil flow rates
  - GOR/CGR
  - Wellhead pressure

  - Downhole flowing pressure.
- If the above measurements are stable then the well may be considered ready for separator sampling.

G. Submission Requirements

The results of all well tests conducted must be submitted to MNIEWR, in electronic format.

All pressure and Production flow tests must be submitted within 60 days of completing the fieldwork, including reporting of volumes and methods produced during cleanup and testing.

- All raw test data must be submitted within 30 days of the well's finished drilling date, including misruns.
- All gas and fluid analysis must be submitted within 45 days of the completion of the test.
- All volumes produced, whether flared, vented or collected (in-line) must also be reported.
- Any of Test reports must be submitted to the MNIEWR office within 60 days of the completion of the test.
- Service company interpretation report should be given within 90 days period maximum. IF the test was failed all data associated with the test and reasons of misleading should be submitted.
- Although there are no standard well testing requirements for bitumen wells, all tests conducted must still be submitted to MNIEWR.

H. Minimum requirement to Monthly production data.

Licenses Holder obliged to provide MNIEWR with monthly report for each well of each field which include following information:

- Field
- Well
- Status of the well: Production, injection or shut-in
- Days of production, injections and non-working days
- Any workover performed
- Daily production or injections per well/wellbore/interval and facility
- Daily Water-Gas Ratio (for gas wells only), Gas-oil Ratio. Water –Oil ration.
- Daily BHP
- Daily Tubing and Casing pressure
- Daily allocated marketable products per facility/field (value adjusted),
- Injections per well/wellbore/interval and facility (gas, water, others, volume)
- Updated production forecast till end of well life on month base.
- Production forecast till end of well technical life reviewed if plan-fact analysis showed more than 10% difference.
- H2S
- Other requirements depends on specific of reservoir, methods of exploitation including EOR. Those requirements will be defined by MNIEW individually and Interest holder should follow them up.

If production result will be different from forecast made at previous 1 month more than 15 %, it could reason of MNIEWR request for additional tests and well review**.**

I. Basic rules for Wells tests in Shale reservoirs /mother rocks reservoirs

As written above, " hydrocarbons discovery could be confirmed only based on longer Pressure transient test which could fully prove commercial effectiveness of future production". Commercial effectiveness and protection from environmental problems are very critical questions while exploration/development of shale oil/gas reserves and should be properly illustrated at all Interest Holder's program, plans and final reports.

For design of Well test, following parameters should be defined and presented to MNIEWR at Well Test proposal to prove methods and target interval of well test: hydrocarbon source rocks, depositional environment, depth, areas of high total organic carbon (TOC), areas of oil/gas window maturity, composition of the rocks, free gas and free oil, absorbed gas, net-organically rich shale thickness, permeability and fractured zones, geomechanical characteristics, overpressure etc. Those paramethers should be defined based on reliable data set (logs (Conventional and Special, like NMR, image logs etc), core analysis (Rutine and Special, RockEval), field survey, others). Original data and result of the processing and interpretation should be provided to MNIEWR before Well Test Proposal.

Well test should confirm existance of free fluid flow, demonstrate productivity of the formation in case of application of certain methods of exploitation and allow to estimate commercial effectiveness.

Due to low permeability of shale reservoir, wells tests shall be accompanied by hydraulic fracturing or other methods for increase of productivity. Those methods of productivity increase shall be presented to MNIEWR at Well test Proposal and preliminary described at Well proposal. All those methods required special technics to planning and execution, control of quality of well bore, QHSE approaches and process monitoring, all those should be at the documents above.

Execution of some types of described above wells' tests could be considered for exemptions depends on type of reservoir and maturity of Hydrocarbons and should be discussed with MNIEWR at each of the case, 90 days prior supposed date of well test operation in accordance with present document. Logs, core data, previously done tests, field data should be properly collected from target zone and should cover upper and lower sections of the wells. All wells and field data with interpretation reports should be provided to MNIEWR in case of request for exemption of the test.

Fluid samples in case of liquid-reach shale formation should be taken and associated analysis should be done.

Production from the well should be monitored for per Clause H to evaluate its performance.