Allowable Rate of Production: Oil Wells

Directive PNG012

June 2024

Revision 1.2

Governing Legislation:

Act:	*The Oil and Gas Conservation Act*
Regulation:	*The Oil and Gas Conservation Regulations, 2012*
Order:	70/24

Saskatchewan

Record of Change

Revision	Date	Description
0.0	September, 2015	Draft
1.0	November, 2015	Live Version, Added Directive Number
1.1	March, 2020	Update of EA Table in Appendix 4
1.2	June, 2024	Updated to: promote clarity and consistency with other directives regarding the allowable rates and off-target wells; incorporate changes to support the new Maximum Permissible Rate application functionality implemented in IRIS in August 2023 (i.e., routine and non-routine application); remove Appendices 1 and 2; clarify Appendix 3 and re-number as Appendix 2.

Contents

1. Introduction

The Saskatchewan Ministry of Energy and Resources (ER) regulates the production of oil wells in the province in order to ensure equitable distribution of the resources, particularly in relation to off-target wells, and to minimize the impacts of resource depletion on oil pools. ER achieves these objectives by assigning and monitoring production limits for oil wells in the province.

This Directive outlines how ER assigns production limits for different types of oil wells, how various penalties on production are calculated, and how an operator is to deal with underproduction and overproduction.

Questions concerning the requirements outlined in this document may be directed to the ER Service Desk at 1-855-219-9373 or email at ER.servicedesk@gov.sk.ca.

1.1 Governing Legislation

The requirements outlined in this Directive are authorized under and supported by:

- *The Oil and Gas Conservation Act* (OGCA)
- *The Oil and Gas Conservation Regulations, 2012* (OGCR)
- Minster's Order 379/18: Spacing Area "E" (MRO 379/18)
- Associated Directives and Guidelines:
  - *Directive PNG006: Horizontal Well Requirements* (Directive PNG006)
  - *Directive PNG007: Off-Target Well Completion Requirements* (Directive PNG007)
  - *Directive PNG009: Public Notice Requirements* (Directive PNG009)
  - *Directive PNG017: Measurement Requirements for Oil and Gas Operations* (Directive PNG017)
  - *Guideline PNG021: Determining Drainage Units and Target Areas* (Guideline PNG021).

Clauses 17(1)(d), (e) and (f) of the OGCA provide ER with the authority to regulate, limit and allocate production from one or more oil wells. Subsection 33(1) of the OGCR contains the regulations specific to allowable rates of oil production. Licensees should consult these documents in conjunction with this Directive.

It is the responsibility of all operators, as specified in the legislation, to be aware of ER requirements and to ensure compliance with these requirements prior to and during the productive life of an oil well.

1.2 Definitions

Allowable rate of production (ARP): means the assigned daily limit on oil production, which could be one of the following: daily allowable; minimum allowable; maximum permissible rate (MPR); maximum permissible rate–off-target penalty (MPR–OTW Penalty); good production practice (GPP); or economic allowance (EA).

Application: means an application to the Minister through the Integrated Resource Information System (IRIS).

Block: a block is equal to the drainage area of a horizontal well, as defined in DirectivePNG006.

Block MPR: is the sum of all maximum permissible rates for all vertical well drainage units withina block.

Economic allowance (EA): is the daily production rate calculated based on well type (non-horizontal or horizontal) and well completion (non-horizontal wells) or wellbore (horizontal wells) depth.

Gas-oil ratio (GOR): means the ratio of the number of cubic meters (m^3) of gas produced from a given source in a given period to the number of m^3 of oil produced from that source in that period.

Gas-oil ratio penalty factor (GOR_{PF}): is a multiplier that is applied to any maximum permissible rate or economic allowance value. The GOR penalty factor is based on the GOR from the previous producing month (see section 4 in this Directive for more details on GOR penalty factors).

Good production practice (GPP): means production of oil from a well at a rate not governed by a defined allowable rate of production. The rate is limited to what can be produced on the basis of technical parameters without adversely and significantly affecting the ultimate recovery of oil, or the opportunity of other owners to obtain their share of production from the pool.

Maximum permissible rate of production (MPR): means the maximum amount of oil an operator is authorized via an MPR application to produce in a day from a well or wells.

Month: means a calendar month.

Monthly ARP: means the product of the assigned daily allowable rate of production multiplied by thenumber of days a well is on production within a month.

Off-Target: means a non-horizontal well not completed within the prescribed target area of the drainage unit (see Guideline PNG021 for more information on-target areas and drainage units).

On-Target: means a non-horizontal well completed within the prescribed target area of the drainage unit.

Overproduction: means the production of an oil well in excess of the monthly allowable in a given month.

Pay: means the thickness of rock that can deliver hydrocarbons to the wellbore via the completion.

Recovery multiplier (RM): is a factor, based on the wellbore length, used to calculate the adjusted block MPR value for horizontal wells.

Underproduction: means the production of an oil well less than the monthly ARP in a given month.

2. Well Completions Governed by Good Production Practice

2.1 Non-Horizontal Well Completions

A non-horizontal well completion that is located within the area and stratigraphic units outlined as being within Spacing Area "E" (see MRO 379/18), and not subject to an off-target penalty (see Directive PNG007 for an explanation of off-target) will have an ARP of GPP assigned.

A non-horizontal well completion that has been granted approval for GPP via a Pool Order or other prior approval, and which is not subject to an off-target penalty, will have an ARP of GPP assigned.

2.2 Horizontal Well Completions

A horizontal well completion that is located within the area and stratigraphic units outlined as being within Spacing Area "E" (see MRO 379/18) or that has been granted approval for GPP rates of production by a Pool Order or other prior approval, will have an ARP of GPP assigned.

To obtain prior approval, a GPP application must be made through IRIS and requires ER review and approval. The application may be subject to the public notice requirements set forth in Directive PNG009.

3. Well Completions Not Governed by Good Production Practice

Any proposed well completion that does not have approval for GPP will be assigned one of the ARPs set out in subsections 3.1, 3.2 or 3.3.

3.1 Economic Allowance

A **non-horizontal well completion** not approved for GPP, and not subject to an off-target penalty, will be assigned an Economic Allowance (EA). The EA production rate is based on the well's depth, measured as the vertical depth from the kelly bushing to the top of the producing pool.

A **horizontal well completion** that is not assigned GPP will default to an EA.

For a horizontal well with a single wellbore, the EA is the total measured depth from the kelly bushing to the end of the productive wellbore.

For a horizontal well with multiple wellbores, the EA is the total measured depth from the kelly bushing to the end of the longest productive wellbore.

The GOR penalty factor applies to the EA of a well.

Appendix 1 contains a table of EA values relative to depth for horizontal and non-horizontal wells.

3.2 Maximum Permissible Rate

MPR applications will be handled as either routine or non-routine in IRIS. If the calculated MPR is above the minimum and below the maximum allowable values for the corresponding pool, the application will automatically be approved as routine after submission. If the calculated MPR is below the minimum or above the maximum allowable values for the corresponding pool, the application will be deemed as non-routine and requires ER review prior to being approved or denied.

The minimum and maximum allowable value ranges at the pool level are assessed and maintained in IRIS by ER based on available pool and well data and are viewable to ER only. These values are derived through statistical analysis methods utilizing historically approved MPR values. However, the authorized MPR value for a well completion can be viewed by all IRIS users. For validation purposes, any routine application may be audited for correctness. If an error has been made in the routine application, the applicant will be contacted and notified of the errors and/or omissions that require addressing.

For a **non-horizontal well completion** that is not under off-target penalty, a company may, at any point after drilling, apply through IRIS for an MPR.

The MPR for non-horizontal wells is calculated using the following equation:

$$MPR = 0.5 \times F_A \times F_H \times F_\phi \times F_{Sw} \times F_{1/Boi}$$

where:

F_A is the area factor, which is equal to the drainage unit expressed in legal subdivisions (LSDs) multiplied by 1.0188;

F_H is the thickness factor, and it is equal to the thickness of the pay expressed in meters to the nearest one tenth of a meter;

F_ϕ is the porosity factor, which is equal to the average porosity of the pay used to calculate F_H, above, expressed in per cent (%) and divided by 10;

F_{Sw} is the interstitial water factor, which is equal to 1 minus the average interstitial watercontent of the pay used in F_H, above, expressed as a decimal, divided by (1-0.25); and

$F_{1/Boi}$ is the shrinkage factor, which is equal to the change in volume of oil from reservoir conditions to stock tank conditions, expressed as a decimal, divided by 0.75.

For a **horizontal well completion**, a company may, at any point after drilling, apply through IRIS for an MPR.

The maximum rate of production for a horizontal oil well is calculated as the combined rate at which non-horizontal oil well MPRs within a block are allowed to produce (“block MPR”), and it is equal to the block MPR multiplied by the recovery multiplier (RM). The RM factor, which cannot exceed 2.0, is derived from the equation below:

$$RM = 1 + (L-100)/500$$

where L is the length in meters (m) of the productive portion of the horizontal wellbore of a horizontal well, or the sum of the productive horizontal wellbores of the horizontal well.

So, a maximum rate of production for horizontal oil wells within a block is:

block MPR (sum of MPR of each vertical drainage unit within the block) x RM

A maximum permissible rate of production is subject to a GOR penalty factor.

3.3 Off-Target Wells- Non-Horizontal Wells Only

3.3.1 Default to Minimum Allowable

Any off-target well completion subject to an off-target penalty will default to a minimum allowable production rate of 3.0 m^3 per day (m^3/day).

A GOR penalty factor does not apply to an ARP that has been set at the Minimum Allowable.

3.3.2 Maximum Permissible Rate – Off-Target Penalty

If a well completion is off-target, a licensee may apply for a maximum permissible rate-off-target well penalty (MPR-OTW penalty).

The MPR–OTW penalty is set based on the distance of the off-target completion from the center of the target area. The equation used to calculate the MPR shown in section 3.2, above, is also used to calculate the MPR–OTW penalty, but the F_A factor in these cases is reduced in proportion to the distance of the well completion from the center of the assigned target area.

So, for example, for a well with a single LSD drainage unit, a well completion that is on-target or has no off-target penalty will have F_A = (1) x 1.0188.

If there is an off-target penalty where the well completion's distance from the center of the target area reduces the LSD area by 25 per cent, then the F_A = 0.75(1) x 1.0188.

Appendix 2 illustrates some examples for determining the net productive area for off-target wells in centered and off-centered target areas within several sizes of drainage units. The production penalty applied to the allowable production of the well is the fraction obtained by dividing the net productive area by the original area of the drainage unit.

The MPR–OTW penalty application is submitted using the standard MPR Application, but a licensee reduces the F_A used in the form by the amount calculated using the formula above.

4. GOR Penalty

For both horizontal and non-horizontal oil wells, the GOR penalty is determined the same way.

For any month, the GOR_{PF} will be determined by ER using the GOR from the previous producing month. The gas production used to calculate the GOR will include those gas volumes measured and/or estimated during testing, plus all gas liberated when the pressure of the crude oil is decreased from treater or separator conditions to stock tank conditions. The measurement requirements for oil and gas operations are set forth in Directive PNG017.

The following penalty factors apply:

- if the produced GOR is less than the base GOR,

$$\text{GOR penalty factor} = 1.0$$

- if the produced GOR is greater than the base GOR, rounded to nearest 0.01,

$$\text{GOR penalty factor} = \frac{\text{Base GOR}}{\text{Produced GOR}}$$

where "base" GOR = 177 m^3/m^3 (unless otherwise ordered by the Minister), and "produced" GOR is the GOR calculated for the well in the previous producing month, to the nearest 0.1 m^3/m^3.

Note: A licensee is expected to monitor the monthly ARP for their wells.

Note: All production monitoring by ER factors in the GOR_{PF}, where applicable.

5. Testing

For testing purposes, an oil well may produce up to 160 m^3 more than its daily allowable rate of production during the first 60 days of production, from any producing pool without penalty.

6. Overproduction

All overproduction is cumulative.

An oil well operator is responsible for keeping a record of current and cumulative overproduction, and for correcting any overproduction as soon as possible without notification from ER.

If the overproduction is not being addressed, or if production in any day exceeds the allowable rate of production by more than 25 per cent, ER may require the operator to submit additional information, shut-in the well for a specified period of time, or take some other action as deemed advisable by the Minister.

If a well is required to be shut-in, in accordance with subsection 77(1) of the OGCR, the Minister may seal or cause to be sealed any or all valves at the well.

7. Underproduction

Correcting overproduction is done by underproducing a well.

The amount of underproduction in any month is applied against the amount of cumulative overproduction.

Underproduction will only be considered cumulative when attempting to mitigate overproduction.

8. Assignment or Revocation of ARP and GPP by Ministerial Authority

Notwithstanding any of the requirements in this Directive, ER may:

- assign GPP to a single well, group of wells, application area, pool or project;
- assign an ARP to a single well or group of wells;
- assign concurrent production to a well or group of wells; or
- assign an ARP to a single horizontal well within a block containing more than one horizontal well.

The requirements of this Directive are subject to and may be superseded by any order made by the Minister relating to a specific well, block, pool or area.

The Minister, at any point, may revoke GPP and assign an MPR or Minimum Allowable to a well completion if, in the opinion of the Minister, the well is not being produced in accordance with GPP.

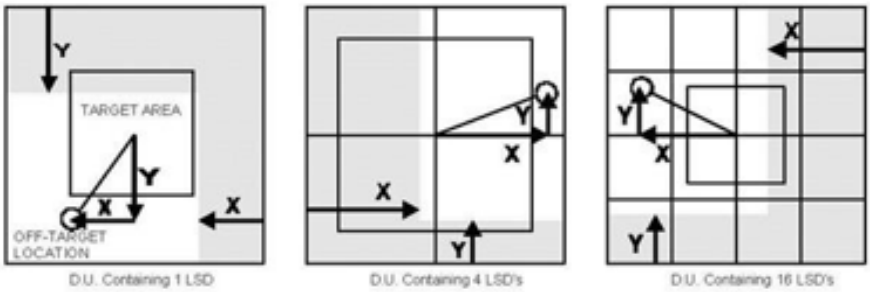
Appendix 1: Table of Economic Allowance Values for Non-Horizontal and Horizontal Oil Wells

Well Depth (m)	Economic Allowance Non-Horizontal Wells (m^3/d)	Economic Allowance Horizontal Wells (m^3/d)	Well Depth (m)	Economic Allowance Non-Horizontal Wells (m^3/d)	Economic Allowance Horizontal Wells (m^3/d)
0 - 180	4.8	19.2	2591 - 2650	8.2	32.8
181 - 270	4.9	19.6	2651 - 2710	8.3	33.2
271 - 360	5	20	2711 - 2770	8.4	33.6
361 - 450	5.1	20.4	2771 - 2825	8.5	34
451 - 540	5.2	20.8	2826 - 2880	8.6	34.4
541 - 625	5.3	21.2	2881 - 2940	8.7	34.8
626 - 700	5.4	21.6	2941 - 2995	8.8	35.2
701 - 780	5.5	22	2996 - 3050	8.9	35.6
781 - 860	5.6	22.4	3051 - 3105	9	36
861 - 930	5.7	22.8	3106 - 3160	9.1	36.4
931 - 1005	5.8	23.2	3161 - 3210	9.2	36.8
1006 - 1085	5.9	23.6	3211 - 3260	9.3	37.2
1086 - 1165	6	24	3261 - 3305	9.4	37.6
1166 - 1240	6.1	24.4	3306 - 3350	9.5	38
1241 - 1310	6.2	24.8	3351 - 3400	9.6	38.4
1311 - 1395	6.3	25.2	3401 - 3600	9.7	38.5
1396 - 1470	6.4	25.6	3601 - 3700	9.9	39
1471 - 1545	6.5	26	3701 - 3800	10	39.4
1546 - 1620	6.6	26.4	3801 - 3900	10.1	40.2
1621 - 1690	6.7	26.8	3901 - 4000	10.3	40.8
1691 - 1765	6.8	27.2	4001 - 4200	10.6	42
1766 - 1830	6.9	27.6	4201 - 4400	10.9	43.2
1831 - 1900	7	28	4401 - 4600	11.2	44.4
1901 - 1970	7.1	28.4	4601 - 4800	11.5	45.5
1971 - 2035	7.2	28.8	4801 - 5000	11.8	46.7
2036 - 2100	7.3	29.2	5001 - 5200	12.1	47.8
2101 - 2165	7.4	29.6	5201 - 5400	12.4	49.1
2166 - 2230	7.5	30	5401 - 5600	12.7	50.3
2231 - 2290	7.6	30.4	5601 - 5800	13	51.4
2291 - 2355	7.7	30.8	5801 - 6000	13.3	52.6
2356 - 2415	7.8	31.2	6001 - 6200	13.6	53.8
2416 - 2475	7.9	31.6	6201 - 6400	13.9	55
2476 - 2535	8	32	6401 and deeper	14	55.6
2536 - 2590	8.1	32.4			

Appendix 2: How to Calculate Net Productive Area for Off-target Wells

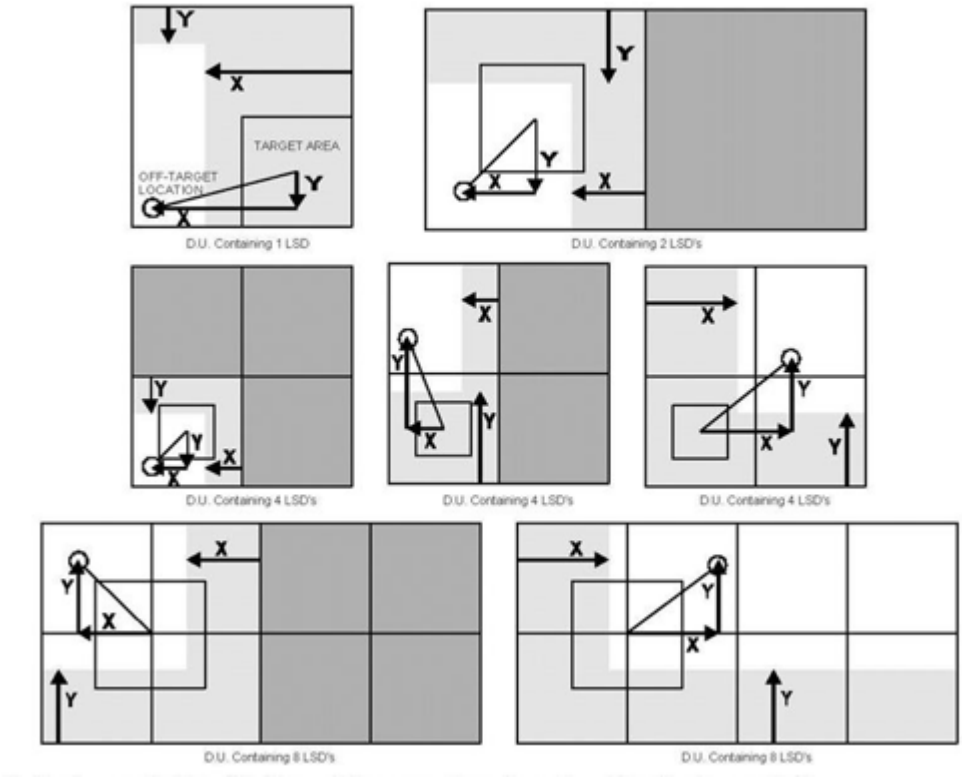
The principles for determining the net productive area (or unpenalized area) for a vertical well not completed within its target area are as follows:

1. In a drainage unit where the target area is centered on the drainage unit, the net productive area is the remaining area of the drainage unit after the north-south and east-west dimensions of the drainage unit have been reduced by the respective distances equal to the north-south and east-west vectors of displacement of the well from the center of the target area;



X= distance from center of target area to actual off-target location / E-W vector of displacement; and
Y = distance from center of target area to actual off-target location / N-S vector of displacement.

2. In a drainage unit where the target area is not centered on the drainage unit:
   a. any legal subdivisions that do not form any part of the target area and are located in a position that is in the opposite direction of a vector of displacement are removed from the drainage unit; and
   b. the net productive area is the remaining area of the drainage unit after the north-south and east-west dimensions of the drainage unit have been further reduced by the respective distances equal to the north-south and east-west vectors of displacement of the well from the center of the target area.



X= distance from center of target area to actual off-target location / E-W vector of displacement; and
Y = distance from center of target area to actual off-target location / N-S vector of displacement.

The penalty factor is calculated using the following equation:

$$\text{Penalty Factor} = \frac{\text{Net Productive Area}}{\text{Total Area of Drainage Unit}}$$

where:

Net Production Area = (Length of Drainage Unit- X) x (Width of Drainage Unit - Y); and

Total Area of Drainage Unit = Length x Width of Drainage Unit or the area of drainage unit

Below is an example on how off-target penalty factor is derived:

DU= 1 LSD, TA= the sides of the target area are located 100 m from and parallel to the corresponding sides of DU;
Off-target Well Coordinates: 50 m E of W and 50 m N of S (Reference point SW corner);
If DU Length= 400 m and DU Width = 400 m, then X= 150 and Y= 150;
Penalty Factor= [(400 - 150) x (400 - 150)] / (400 x 400)
Pentalty factor = [(250 x 250)/160000] = 0.39