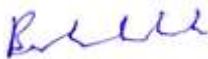


Certification report	3 Oaks Gaming RNG Evaluation for Colombia
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Supervisor	Baha Ansari
Signature	
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Jurisdiction	Colombia
Technical standards used for testing	Coljuegos Technical Requirements for Internet Games Operated in Colombia May 20, 2020

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1 Notations

1.1 Confidentiality

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This document, its themes, and ideas are strictly confidential and may not be used in any manner other than its expressed purpose, without the written permission of the author. The documents are for the intended client named in this report, also referred to as "the client" or "client", and the applicable gaming jurisdiction mentioned in this document.

The documents are copyright.

1.2 Disclaimer

ga has reported on what it has discovered throughout the assessment period of the client's RNG related to the technical scope of testing as per applicable jurisdictional requirements. Results are based on the client's submission of information material, source code, and access to the testing environment and applicable testing is performed within a finite period.

Inherently there are limitations in performing compliance testing within a laboratory environment and accordingly **ga** has undertaken its best endeavours to ensure a thorough assessment is performed and conclusion stated.



2 Administration

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2.2 Version

Version	Description	Date
V0.1	Initial Draft – FREH	2022-05-16
V0.2	Review and Updated – WKAS	2022-05-17
V0.3	QA – BANS	2022-05-18
V1.0	Final report to 3 Oaks Gaming	2022-05-20



3 Executive Summary

3.1 Introduction

3 Oaks Gaming (3 Oaks Gaming) has requested Gaming Associates (ga) to evaluate their Random Number Generator (RNG) being used in online games against the jurisdiction of Colombia as regulated by Coljuegos.

This report presents the results of testing performed by ga related to the technical scope of testing as per applicable jurisdictional requirements. Hashes of the critical components of RNG are listed in Annex B: SHA-1 Hashes.

3.2 Description of the systems component being certified

3 Oaks Gaming New object of Random generator creates per GS process with own seed. If process dies, new random object with random seed will be created. The algorithm used for the pRNG is Mersenne Twister generator but have os.urandom as option (On a Unix-like system, random bytes are read from the /dev/urandom device).

3.3 Testing methodology

The following test methods have been used for compliance evaluation of the RNG:

- ♣ documentation review;
- ♣ source code review;
- ♣ statistical Analysis of RNG outputs

No sampling has been used during games testing as this is not applicable.

3.4 Scope of Testing

The scope of evaluation of RNG was testing against the following game related requirements of “Coljuegos Technical Requirements for Internet Games Operated in Colombia May 20, 2020”:

- ♣ Chapter III. General aspects of the games operated by Internet

3.5 Conclusions and Recommendations

Subject to the scope of testing and on the basis of testing performed by ga 3 Oaks Gaming has formed an opinion that the submitted RNG complies with the applicable technical standards of the jurisdiction of Colombia as regulated by Coljuegos.

4 Test Results

This section summarises the results of the tests performed on 3 Oaks Gaming pRNG. The tables in the following sub-sections provide the assessment of compliance status of the pRNG against the applicable requirements of the technical standards of the jurisdiction of Colombia as regulated by Coljuegos.

The different values used in the tables below within the “Compliance Status” column is described as follows:

Compliant: The testing results comply with the requirement.

Acknowledged: The requirement is only a statement or information.

N/A: The requirement is not applicable for the current product testing.

Out of scope: The requirement is not evaluated at this stage due to the current scope of testing or limitation of the test environment.

4.1 Chapter III. General aspects of the games operated by Internet

Req #	Requirement Description	Compliance Status	Observations and Evidence
	CHAPTER III. GENERAL ASPECTS OF THE GAMES OPERATED BY INTERNET		
3.2	RANDOM NUMBER GENERATOR - GNA		
	Random Number Generator - RNG must meet at least the following requirements:		
	Random data generated must be statistically independent.	Compliant	The random numbers generated by 3 Oaks Gaming passed diehard testing suite with overall confidence level of above 99%. The raw (binary) output of pRNG passed statistical tests demonstrating that the data is statistically independent. Annex A contains results of statistical tests conducted on raw random numbers data generated from 3 Oaks Gaming.
	Random data generated will be unpredictable and undeterminable purposes predict outcomes of future game. (Its prediction must be impossible for computer without knowing the algorithm and the seed).	Compliant	Seeding and re-seeding does not introduce any predictability as the seed is the combination of instance hash code and current time.
	Series data generated will not be reproducible.	Compliant	3 Oaks Gaming pRNG use the random seed value and will not be reproduced.
	Scaling methods will be linear and will not introduce any bias, pattern or Predictability.	Compliant	Scaling of raw RNG outcomes does not introduce bias, pattern, or predictability.
	The translation method of the symbols or the game results will not be subjected to influence or control of a factor other than numerical values derived from the random number generator	Compliant	Game symbol drawing process uses only numerical values derived from the RNG in conjunction with game rules.
	The random data must be uniformly distributed within the range settled down.	Compliant	The scaling ranges are mapped with the game symbols uniformly.
	Random data must remain within the range established	Compliant	Degree of Freedom (DOF) used by the games are within the ranges used by the games and pass the statistical tests.
	Different instances of a GNA should not be synchronized with each other so that the results of some to predict the other.	Compliant	
	Seeded techniques / Re-Seeded should not allow making predictions on the results.	Compliant	Seeding and re-seeding does not introduce any predictability as the seed is the combination of instance hash code and current time.
	Generation mechanisms must have successfully passed various tests	Compliant	



Req #	Requirement Description	Compliance Status	Observations and Evidence
	statistics showing its random nature.		
	Technical Gaming System may require several GNA, in which case all must meet the above requirements; it can also happen that share one or GNA instance of the same for one or more games, this applies if the behaviour does not affect random system.	Compliant	pRNG cycling is random and secure and cannot be altered during the games. 3 Oaks Gaming use only one pRNG and there is no use of multiple RNGs.
	The operator shall implement a monitoring system that allows you GNA detect its faults and define the methods and criteria for evaluation of the ruling that allow the mechanisms established to make the decision whether to or not to disable the play when a fault in the GNA that impact on the development of the game takes place.	Compliant	
3.3	APPLICATION OF RANDOM NUMBER GAMES	Out of scope	The scope of testing is limited to the RNG. This requirement is related to operational procedures and hence it is the operator's responsibility.
	• The range of values of the GNA must be precise and not distort the percentage of return to the player.		
	• The game should not handle random events, or manually, or automatically, or to maintain a minimum percentage return to the player.		
	• The translation method of the symbols or the game results should not be under the influence or controlled by another factor than the values numerical derivatives of the GNA.		
	• Random events should be governed exclusively by the GNA and should not there is no correlation between a few plays and others.		
	• The game should not rule out any random event, except in cases this circumstance is contemplated in the rules of the game.		
	• When the rules of the game require the drawing of a sequence of events random (for example, cards in a deck), random events will not be sequenced during the course of the game, except in those cases where this circumstance is contemplated in the rules of the game.		



5 References

1. *Coljuegos Technical Requirements for Internet Games Operated in Colombia May 20, 2020.*



Annex A : Statistical testing of RNG output

The following table presents the summary of diehard test results. These tests were applied on raw output of the pRNG supplied by 3 Oaks Gaming. The data has passed all tests in the diehard battery of tests with 99% confidence level.

The results for each data file are given below.

Data file: raw_1.txt

Test No.	Description	p-value	Test results (Pass/Fail)
1	BIRTHDAY SPACINGS TEST	0. 571415	Pass
2	BINARY RANK TEST for 32x32 matrices	0. 902496	Pass
3	BINARY RANK TEST for 31x31 matrices	0. 385224	Pass
4	BINARY RANK TEST for 6x8 matrices	0. 977358	Pass
5	BITSTREAM TEST	0. 556982	Pass
6	Overlapping Pairs-Sparse-Occupancy (OPSO) Test	0. 547265	Pass
7	Overlapping-Quadruples-Sparse-Occupancy (OQSO) Test	0. 47815	Pass
8	DNA test	0.490770	Pass
9	COUNT-THE-1's TEST		
	(i) byte stream for 2549.59 chi-square value	0. 758448	Pass
	(ii) byte stream for 2492.78 chi-square value	0. 459321	Pass
10	COUNT-THE-1's TEST for specific bytes	0.586613	Pass
11	PARKING LOT TEST	0. 783975	Pass
12	MINIMUM DISTANCE TEST	0. 338061	Pass
13	3DSPHERES TEST	0. 347259	Pass
14	SQUEEZE TEST	0. 231966	Pass
15	OVERLAPPING SUMS test	0. 506370	Pass
16	THE RUN TEST		
	(i) Runs up Test	0. 042790	Pass
	(ii) Runs Down Test	0. 683496	Pass
	(iii) Runs up Test	0. 682297	Pass
	(iv) Runs Down Test	0. 140863	Pass
17	CRAPS TEST		
	(i) No. of wins	0. 768566	Pass
	(ii) for throws/game	0. 298778	Pass



Test No.	Description	p-value	Test results (Pass/Fail)
18	OVERLAPPING 5-PERMUTATION TEST		
	(i) Sample of 1,000,000 consecutive 5-tuples	0. 635268	Pass
	(ii) Sample of 1,000,000 consecutive 5-tuples	0. 078592	Pass

Data file: raw_2.txt

Test No.	Description	p-value	Test results (Pass/Fail)
1	BIRTHDAY SPACINGS TEST	0. 748224	Pass
2	BINARY RANK TEST for 32x32 matrices	0. 500398	Pass
3	BINARY RANK TEST for 31x31 matrices	0. 606425	Pass
4	BINARY RANK TEST for 6x8 matrices	0. 079764	Pass
5	BITSTREAM TEST	0.461091	Pass
6	Overlapping Pairs-Sparse-Occupancy (OPSO) Test	0.388604	Pass
7	Overlapping-Quadruples-Sparse-Occupancy (OQSO) Test	0.679464	Pass
8	DNA test	0.445383	Pass
9	COUNT-THE-1's TEST		
	(i) byte stream for 2475.62 chi-square value	0. 365131	Pass
	(ii) byte stream for 2523.61 chi-square value	0. 630798	Pass
10	COUNT-THE-1's TEST for specific bytes	0.536258	Pass
11	PARKING LOT TEST	0. 537076	Pass
12	MINIMUM DISTANCE TEST	0. 149420	Pass
13	3DSPHERES TEST	0. 721184	Pass
14	SQUEEZE TEST	0. 200846	Pass
15	OVERLAPPING SUMS test	0. 445290	Pass
16	THE RUN TEST		
	(i) Runs up Test	0. 046670	Pass
	(ii) Runs Down Test	0. 852398	Pass
	(iii) Runs up Test	0. 146116	Pass
	(iv) Runs Down Test	0. 818765	Pass
17	CRAPS TEST		
	(i) No. of wins	0. 541216	Pass
	(ii) for throws/game	0. 953812	Pass
18	OVERLAPPING 5-PERMUTATION TEST		
	(i) Sample of 1,000,000 consecutive 5-tuples	0. 762189	Pass
	(ii) Sample of 1,000,000 consecutive 5-tuples	0. 948793	Pass



A.1 Scaled output of RNG

The following table describes the results of statistical testing performed on scaled data used to generate games results for 3 Oaks Gaming games.

The data passed the statistical tests within 99% confidence level which are accepted standard levels for statistical tests of this nature. This confirms that the game outcomes are random and uniformly distributed over the range required by each game.

Data File Name: Data1.txt

Degree of Freedom: 36

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
36	Data1.txt	Chi-Square	1,000,000	3.8070e+001	Pass
		Runs-up	1,000,000	1.9123e-003	Pass
		Runs-down	1,000,000	2.0041e-003	Pass

Data File Name: Data2.txt

Degree of Freedom: 36

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
36	Data2.txt	Chi-Square	1,000,000	4.3673e+001	Pass
		Runs-up	1,000,000	1.8659e-003	Pass
		Runs-down	1,000,000	1.9995e-003	Pass

Correlation between "Data1.txt" and "Data2.txt"

Sampling size	correlation coefficient	Pass/Fail
1,000,000	1.8590e-003	Pass

Data File Name: Data1.txt

Degree of Freedom: 51

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
51	Data1.txt	Chi-Square	3,000,000	5.3231e+001	Pass
		Runs-up	3,000,000	1.2540e-003	Pass
		Runs-down	3,000,000	1.1982e-003	Pass

Data File Name: Data2.txt

Degree of Freedom: 51

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
51	Data2.txt	Chi-Square	3,000,000	5.6248e+001	Pass
		Runs-up	3,000,000	1.2108e-003	Pass
		Runs-down	3,000,000	1.1611e-003	Pass

Correlation between "Data1.txt" and "Data2.txt"

Sampling size	correlation coefficient	Pass/Fail
3,000,000	9.9012e-004	Pass

Data File Name: Data1.txt

Degree of Freedom: 99

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
99	Data1.txt	Chi-Square	3,000,000	9.4022e+001	Pass



DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
		Runs-up	3,000,000	4.2356e-004	Pass
		Runs-down	3,000,000	4.1960e-004	Pass

Data File Name: Data2.txt

Degree of Freedom: 99

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
99	Data2.txt	Chi-Square	3,000,000	1.1716e+002	Pass
		Runs-up	3,000,000	4.0259e-004	Pass
		Runs-down	3,000,000	4.3300e-004	Pass

Correlation between “Data1.txt” and “Data2.txt”

Sampling size	correlation coefficient	Pass/Fail
3,000,000	-1.4725e-003	Pass

Data File Name: Data1.txt

Degree of Freedom: 774

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
774	Data1.txt	Chi-Square	1,000,000	8.0787e+002	Pass
		Runs-up	1,000,000	1.3441e-004	Pass
		Runs-down	1,000,000	1.4644e-004	Pass

Data File Name: Data2.txt

Degree of Freedom: 774

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
774	Data2.txt	Chi-Square	1,000,000	7.5981e+002	Pass
		Runs-up	1,000,000	1.5268e-004	Pass
		Runs-down	1,000,000	1.6690e-004	Pass

Correlation between “Data1.txt” and “Data2.txt”

Sampling size	correlation coefficient	Pass/Fail
1,000,000	-4.5243e-004	Pass

Data File Name: Data1.txt

Degree of Freedom: 499999

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
499999	Data1.txt	Chi-Square	10,000,000	4.9953e+005	Pass
		Runs-up	10,000,000	1.5152e-004	Pass
		Runs-down	10,000,000	1.5910e-004	Pass

Data File Name: Data2.txt

Degree of Freedom: 499999

DOF	Data File	Statistical test	Sampling size	Sum of square of residuals	Pass/Fail
499999	Data2.txt	Chi-Square	10,000,000	4.9762e+005	Pass
		Runs-up	10,000,000	1.6402e-004	Pass
		Runs-down	10,000,000	1.3486e-004	Pass

Correlation between “Data1.txt” and “Data2.txt”

Sampling size	correlation coefficient	Pass/Fail
10,000,000	8.2701e-004	Pass

**Annex B : SHA-1 Hashes**

SHA1 hashes of the pRNG are listed in the table below:

<i>Critical File Name</i>	<i>Description</i>	<i>SHA-1 hashes</i>
<i>rng.py</i>	<i>common library methods for RNG</i>	c833b0d5cafccf72281fab1398e0be58a6fe69c8
<i>mersenne_twister.py</i>	common library of RNG source files	03a7f81f656a6d8754132bb7e682acc843d79218

End of Document