



RANDOM NUMBER GENERATOR EVALUATION CERTIFICATE

FOR

OCTOPUS SOFTWARE SYSTEMS LIMITED

**CERTIFICATE NUMBER:
80538OGL001**

CONFIDENTIAL

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1. INTRODUCTION

Octopus Software Systems Limited requested eCOGRA to evaluate the randomness of the Random Number Generator (RNG) for an online gambling license application for products deployed in licensed jurisdiction. The Random Number Generator used for the gambling applications is software based.

2. COMPONENTS INSPECTED

License Holder:	Octopus Software Systems Limited
License Holder Address:	Quijano Chambers P.O. Box 3159 Road Town, Tortola British Virgin Islands
Product Name:	Octopus Gaming Random Number Generator
Supplier:	Octopus Software Systems Limited
Product Description:	The Random Number Generator is software based, developed in-house using Java.
Product Version:	1.0
RNG Type:	Software
Jurisdictions:	Multi-Jurisdictional (Gibraltar, Isle of Man, Malta, Italy, Denmark, Bulgaria, Estonia, and Romania)
Test Entity:	eCOGRA
Test Entity Address:	2 nd Floor Berkeley Square House, Berkeley Square, London, W1J 6BD
Date:	07 June 2018
Test Engineer:	Sphamandla Langa, Sthembiso Mvelase, Sikhumbuso Mzobe, Pooveshan Gounden
Supervision and Approval:	Gary Lupton-Smith

3. RNG HARDWARE DETAILS

The scope of the RNG evaluation and certification applies solely to the RNG devices listed in the table below:

Random Number Generator

RNG File Name	Version	MD5 Hash
RandomProvider.java	1.0	6ed5dfa682d7d8ae8a0c029961e3f309
RandomEngine.java	1.0	7c7d61e5cedbd0370b11d642e5c02052

4. TESTS PERFORMED

The scope of the evaluation consisted of an assessment of the following components:

- Documentation;
- Statistical and mathematical analysis;
- Source code;
- RNG range; and
- RNG scaling.

The RNG evaluation was performed to ensure the following requirements were met:

- The data must be randomly generated;
- The data must be unpredictable; and
- The series cannot be reproduced.

The tests used to perform the evaluation included the following:

- Chi-Squared Tests;
- Wald-Wolfowitz (or Runs) Tests;
- Expected probabilities for shuffle decks; and
- Diehard Test Suite.

5. TEST RESULTS

Recognised statistical and mathematical tests were performed to certify the RNG operated in compliance with the requirements stipulated in the regulations of highly regulated online gambling jurisdictions. This included tests for probability (to ensure the expected number of occurrences), randomness (so that one cannot predict the following occurrence with any degree of certainty) and uniformity (to determine that each possible outcome is equally likely over the long-term). The acceptance criteria for the statistical tests is a pass at a 95% confidence level.

1. OUTPUT BASED TESTING ON SCALED RANGES: 0-33, 0-36, 0-51, 0-66, 0-99, 0-500, 0-999
 a. OUTPUT BASED TESTING ON SCALED RANGES RESULTS

OUTPUT BASED TESTING				CLIENT GENERATED DATA			eCOGRA GENERATED DATA		
				Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Test Number	Sample size	Test Range	DoF	P-value	P-value	P-value	P-value	P-value	P-value
1	3 000 000	0-33	33	0.5138	0.6210	0.8304	0.0271	0.1969	0.4954
2	3 000 000	0-36	36	0.6700	0.4736	0.0687	0.4312	0.2646	0.4311
3	3 000 000	0-51	51	0.7653	0.5303	0.2883	0.9350	0.0340	0.8542
4	3 000 000	0-66	66	0.3047	0.9365	0.1166	0.7587	0.4959	0.9701
5	3 000 000	0-99	99	0.6826	0.6826	0.9156	0.7367	0.5612	0.4767
6	3 000 000	0-500	500	0.0407	0.8033	0.1192	0.5801	0.1247	0.6797
7	3 000 000	0-999	999	0.3971	0.8646	0.4395	0.8135	0.9100	0.7972

b. SCALED DATA RANDOMNESS TEST SUCCESS (✓) OR FAILURE (x) SUMMARY

OUTPUT BASED TESTING				CLIENT GENERATED DATA			eCOGRA GENERATED DATA		
				Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Test Number	Sample size	Test Range	DoF	P-value	P-value	P-value	P-value	P-value	P-value
1	3 000 000	0-33	33	✓	✓	✓	✓	✓	✓
2	3 000 000	0-36	36	✓	✓	✓	✓	✓	✓
3	3 000 000	0-51	51	✓	✓	✓	✓	✓	✓
4	3 000 000	0-66	66	✓	✓	✓	✓	✓	✓
5	3 000 000	0-99	99	✓	✓	✓	✓	✓	✓
6	3 000 000	0-500	500	✓	✓	✓	✓	✓	✓
7	3 000 000	0-999	999	✓	✓	✓	✓	✓	✓

2. OUTPUT BASED TESTING ON SHUFFLED DECKS

a. OUTPUT BASED TESTING ON SHUFFLED DECKS RESULTS

OUTPUT BASED TESTING				CLIENT GENERATED DATA			eCOGRA GENERATED DATA		
				Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Tests Number	Sample size	Test Range	DoF	P-value	P-value	P-value	P-value	P-value	P-value
1	3 000 000	5 Card Hands	8	0.3871	0.2712	0.6306	0.4027	0.7024	0.1510
2	3 000 000	7 Card Hands	9	0.3082	0.2957	0.3777	0.5714	0.1834	0.5503
3	3 000 000	5-7 Card Multiples Combinations	17	0.1466	0.4191	0.2235	0.4672	0.4800	0.2785
4	3 000 000	5-7 Card Suit Combinations	29	0.3406	0.6524	0.5521	0.4517	0.6365	0.4206

b. SHUFFLED DECKS RANDOMNESS TEST SUCCESS (✓) OR FAILURE (×) SUMMARY

OUTPUT BASED TESTING				CLIENT GENERATED DATA			eCOGRA GENERATED DATA		
				Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
Tests Number	Sample size	Test Range	DoF	P-value	P-value	P-value	P-value	P-value	P-value
1	3 000 000	5 Card Hands	8	✓	✓	✓	✓	✓	✓
2	3 000 000	7 Card Hands	9	✓	✓	✓	✓	✓	✓
3	3 000 000	5-7 Card Multiples Combinations	17	✓	✓	✓	✓	✓	✓
4	3 000 000	5-7 Card Suit Combinations	29	✓	✓	✓	✓	✓	✓

3. DIEHARD TESTS

a. DIEHARD TEST RESULTS

DIEHARD TEST		CLIENT GENERATED DATA			eCOGRA GENERATED DATA		
Test Name	Sample Size	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
BIRTHDAY SPACINGS TEST	48 000 000	0.0868	0.0232	0.0231	0.1214	0.0406	0.0159
OVERLAPPING 5-PERMUTATION TEST	48 000 000	0.1146	0.2998	0.0253	0.4531	0.5246	0.2507
THE BITSTREAM TEST	48 000 000	0.1072	0.0237	0.0462	0.0581	0.0584	0.0418
COUNT-THE-1's TEST bytes	48 000 000	0.0159	0.0154	0.0424	0.0085	0.0448	0.0015
MINIMUM DISTANCE TEST	48 000 000	0.0518	0.5670	0.2578	0.0015	0.5685	0.2203
SQUEEZE TEST	48 000 000	0.3527	0.7247	0.1209	0.8719	0.9833	0.6579
RUNS TEST	48 000 000	0.2592	0.1255	0.3318	0.2809	0.0496	0.0098
CRAPS TEST	48 000 000	0.1026	0.1828	0.1375	0.2732	0.6547	0.2210

b. DIEHARD TESTS SUCCESS (✓) OR FAILURE (×) SUMMARY

DIEHARD TEST		CLIENT GENERATED DATA			eCOGRA GENERATED DATA		
Test Name	Sample Size	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
BIRTHDAY SPACINGS TEST	48 000 000	✓	✓	✓	✓	✓	✓
OVERLAPPING 5-PERMUTATION TEST	48 000 000	✓	✓	✓	✓	✓	✓
THE BITSTREAM TEST	48 000 000	✓	✓	✓	✓	✓	✓
COUNT-THE-1's TEST bytes	48 000 000	✓	✓	✓	✓	✓	✓
MINIMUM DISTANCE TEST	48 000 000	✓	✓	✓	✓	✓	✓
SQUEEZE TEST	48 000 000	✓	✓	✓	✓	✓	✓
RUNS TEST	48 000 000	✓	✓	✓	✓	✓	✓
CRAPS TEST	48 000 000	✓	✓	✓	✓	✓	✓

6. CONCLUSION

Our test results for the RNG produced statistically acceptable random numbers that were free of any significant statistical bias or predictability. The results obtained from eCOGRA's testing confirm the random number generator operates in compliance with the applicable requirements of the regulations of highly regulated online gambling jurisdictions.

A handwritten signature in black ink, appearing to read "Gary Lupton-Smith".

Project Approval:

Gary Lupton-Smith, Technical Services Manager