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Revised Report

Report N°	2015PTC353RNG00_1
Date	17 February 2015

Issuing Laboratory

GLI Europe B.V.

Evaluating Laboratory

GLI Europe B.V.

Recipient

Playtech Software Limited
2nd Floor, St George's Court
Upper Church Street
Douglas
Isle of Man, IM1 1EE

Tested against Requirements

AGCC - Technical Standards and Guidelines for Internal Control Systems and Internet Gambling Systems, Version 3.5, 25th April 2013. And any other applicable regulation.

Bulgaria -

General technical and functional requirements to gaming software and communication equipment of remote gambling games.

On the terms and procedure for identification and registration of the participants and information storage for the organized gambling games from distance on the territory of republic of Bulgaria and for transmitting information regarding the gambling games to a server of the national revenue agency.

General obligatory technical requirements to the control systems of gambling games and gaming equipment.

France - Arjel DET_EN_15042013 Technical Requirements File Version 1.2 of 24th September 2012, covered by article 11 of decree n°2010-509 of 18th May 2010 relative to the obligations imposed on approved online gaming or betting operators with a view to the online gaming regulatory authority controlling gaming data.

GLI 19 - Interactive Gaming Systems V2.0.

Isle of Man - Isle of Man Online Gambling (Systems Verification Amendment) Regulations 731 – 31-08-2007.

Malta - Remote Gaming Regulations, 2004 – Third Schedule Test Script.

UK remote - Remote Gambling and Software Technical Standards August 2009; Updated October 2014; Testing Strategy for Compliance with Remote Gambling and Software Technical Standards – October 2014.

Denmark -

Testing Standards for Online Casino - SCP.01.03.EN.1.0

Inspection Standards for Online Casino - SCP.02.03.EN.1.0

Spain Online -

Resolution of 6 October 2014 of the Gaming Regulation Board passing the provision developing the technical specifications of gaming, traceability and security which have to be fulfilled by technical gaming systems of a non-reserved nature forming the object of licences granted under the Gaming Regulation Act n° 13/2011 of 27 May.

Italy Online -

Decree of 10th January 2011 - Governance of games of skill and games of chance with fixed odds and non tournament card games with remote participation. Version published on 24th December 2014.

Jurisdiction

Non-Jurisdictional

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Manufacturer	Playtech Software Limited 2 nd Floor, St George's Court Upper Church Street Douglas Isle of Man, IM1 1EE
Submitter	Playtech Software Limited 2 nd Floor, St George's Court Upper Church Street Douglas Isle of Man, IM1 1EE
Product Name	Playtech Multi RNG Evaluation
Product Style	Random Number Generator Evaluation
Description of the Product Tested	Playtech TV RNG, Playtech Bingo RNG, Playtech Poker RNG, Playtech Casino RNG For further details see the Software Product Details section
Date Received / Date Completed	As requested per manufacturer's letter dated 7 th August 2014. 7 th August 2014 / 9 th February 2015
Evaluation Period	3 rd September 2014 / 30 th January 2015
Result	Pass (See Comments and Conditions on page 3)
Sections	<ul style="list-style-type: none">- Comments/Conditions- Hardware Product Details- Software Product Details- Applied Tests- Product Characteristics- RNG Analysis- Terms and Conditions



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Comments/Conditions

Comments

This Revised Report replaces RNG Evaluation Report 2015PTC353RNG00 dated 9th February 2015. This Revised Report was issued in order to add Denmark, Spain Online and Italy Online to the “Tested Against Requirements” on page 1 of this report.

As from 1st July 2006, it is the manufacturer’s responsibility to ensure that their product is RoHS compliant with current EU directives.

The program GLI Verify® V7.0 was used to generate the SHA-1 and MD5 signatures listed in the Software Product Details section of this Report.

This non-jurisdictional Report is not intended to represent the final Report for any of the mentioned jurisdictions, it is for informational purposes only.

This Report is issued for the evaluation of the RNG only and covers the game ranges supplied in the Report.

Conditions

The tested RNG may only be used in connection to games which call the RNG with numbers within the ranges as specified in this Report.





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Hardware Product Details

There are no Hardware Product Details applicable to this Report.



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Software Product Details

Playtech TV RNG

File Name	MD5 Checksum	SHA-1 Checksum
ENG_ROULETTE.pm	34E9B3EF 7E8880D7 2B5C86B8 F296B8C7	212721F7 1E72C4CD 3E4EBA38 659BBE0E 09D48834
random.pm	63274FE1 AED17EE5 A4CCB1AA DC48C257	70C7FBB3 A9353E55 6FD2D856 58116684 B1847ABC
roulette_spots.pm	67B5AF3C C5EDBC1E B45E34C1 83BFA352	A71EC5B9 5986A27A E523B078 498F1F07 0A13DE7A

Playtech Bingo RNG

File Name	MD5 Checksum	SHA-1 Checksum
rng.properties	4FBA6E0A 683B8584 0D47B396 CA392AE1	9A2E6B48 C4E5CD6B CCDBE5CF CCD9D34A 95BDCD26
AccessCountRNGCyclingStrategy.class	8C40A603 6A3A72EB 16B72162 6284D913	B95EFC98 19232608 C216AD02 836F7A0A E92F7E7C
DefaultRNG.class	9A785B34 752455A7 AF2B89E2 789A1E9E	2C2AC97C 0D5529F4 C3158733 9590E8D2 533E1264
DefaultSecureRandom.class	2A3E69FC BD6ADFB2 FE884654 F0B16D15	2C42D303 35D61CF2 9EB22219 BA1F2E63 CA24A4C1
RandomException.class	8036871F 0CF547FB 355E74E6 91ABD848	832FEAD9 C7259793 205AED51 FB503DBC EC29F25B

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Playtech Bingo RNG (continued)

File Name	MD5 Checksum	SHA-1 Checksum
RandomNumberGenerator.class	CFF53ABA 28F502B1 08EABBB8 17C6FF1B	B68292AB 0021A39B C03B0434 E173554E DC30C83E
RandomUtils.class	E18F7B3E 5D45153A E37EE414 5080AA4C	DBAA4C48 0EAB4B6E 68D1158E 8D24255B 345072E4
RNGCyclingStrategy.class	30FE862C 5371F5F1 933F62DB CA48B6B4	BE43474B B9167780 CFE1A79E DE3A11C1 FFC17B6B
SecureRandomWrapper.class	45DCA241 D5EB7542 03A4B59F F8D6C420	2D4EAED6 642949F1 FB4D421B 60998B99 D5B22996
SpecificSecureRandom.class	6E724E42 1FA0457C 0948DEDB B165AD9B	5EC46AFD 00F221C5 5E48171D 80B8B029 DC9D2956
SunSHA1PRNGSecureRandom.class	4B95CB9A 70F199ED 5F31FCB8 A16A3C5B	53C5C7EC FEB8B8D3 69051756 84501655 CA813A10
TimedAccessRNGCyclingStrategy.class	59CEA88E F795D21D DDB70DBB 5E214F96	F7CE7A1F A8CD0C55 5CB8F3A4 F5A408B6 7E61E4D8
RNGFactoryBean.class	ED52889C 3C66695F 55196ABC 875C32B8	68DA7423 8AA08FEA CE215DDC 7ED8C79B CD762BF5

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Playtech Poker RNG

File Name	MD5 Checksum	SHA-1 Checksum
AbstractRngClientSession.class	B51392E3 B13EF51E FEC3E6E8 56AF71E9	3E34EE59 6C6B55BF 864D6641 075D07A4 8BAD4856
BitUtils.class	DEC84208 68A531F7 DAF026A7 AAA48F88	739B3D1C 2819C9B1 1459BAF5 B89F6F5B 21A888B1
BufferLevel.class	44F4335C 2A1F21FC B3AB82B7 D0084294	BBCB3FD1 A1799097 420FA4B7 5F17C468 677E24F9
BufferLevel\$Level.class	3882C5BD 2E79238C 69FB031F 8973A8ED	12EED82A 78E5CFB8 ECA818EB 57AFB9F6 1AEB9EE4
ComPortOptionHandler.class	3EDD86CF 29BC3130 F738AAB9 76948897	F80E19AB D8A693A8 6226EC22 8F7F316E 0354F596
DriverManager.class	CA7EC7F8 A2CCDDFE 7B350CB9 299C9C0F	7F4F914B 6DD19784 1486A17B F8541902 C9F5D561
DriverManager\$1.class	61A18CB7 9228E472 B6818206 F5629164	D897D0CC AA47BE0A 5608C66C 9022C821 A643FD6E
FrequencyAnalyzer.class	53D17712 AAE3DCB8 5B748059 865F7A24	41FC4AEE 45B63A71 85C22891 DE1B30AA 91D89494
GameServerSession.class	715840CD B23AAC4B D287619C D0ED84FD	0948B125 0CCC34B8 3034BDBC FB32775A 02E786A3

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Playtech Poker RNG (continued)

File Name	MD5 Checksum	SHA-1 Checksum
IRandomBuffer.class	1D6C9576 85A0B06E 398F52A3 39DC7362	9E3F4101 6B5402EB 5E590917 5BE3147E B3CEAB7B
IRandomConsumer.class	2D6560F6 86570A51 12447F2E A6AFF966	01BE5B27 9BBB8570 1B313B51 738B8A26 CD8F348A
IRngDriver.class	566CDB40 CF5B9777 3BFB7832 0B34E39C	DE3378D4 C66BB8F5 8D26D270 F0D8381E DBF84CC6
NoiseBufferHelper.class	4BB6B749 3EF40E86 F12DFC72 8E4201D2	7E64533F F0341D94 81F8E61A C48A4D9E 835BE478
PTMetrics.class	9E489BBF D440CA7 A10ED27B 4C9ADF53	D5AFF22A E5E50B9A C24156F8 9B0E2F3E 4CF743C1
PtTelnetClient.class	8D998F66 EA923DEF A1AC0A89 00314FD4	B196A425 2922FAF2 05EFAC2E 20E263E3 5D38A502
RandomBatch.class	17DFAF3E 737E4B74 99CFAFFB 79B8039D	089E97EA EE61B4EA CAE77849 1B385263 DB845AF4
RandomBuffer\$1.class	4FB7DA85 C89B46E7 12731292 7BA71705	918EF823 895A85F3 8E592930 BC7CB92C 791B2C5D
RandomBuffer\$2.class	1EE9380D 50C7F0BA A8D70832 B994191E	48A28D13 22676205 66E687A2 D354306B A7DCD3AD

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File Name	MD5 Checksum	SHA-1 Checksum
RandomBuffer.class	CF5FD7B2 007BBEED B723FCFD FB19D3EA	B454CF42 30F84EC2 0D352CDC 6EA9DEC5 BAAC857D
RandomProvider.class	F9EE1472 8F2E4180 DC8D578B 3729EBA8	8A2956B7 1278F82B D05FEC46 02395F70 49A99DD6
RandomReader.class	2D0AF689 7E5CEF3F 651B21A7 E53279F8	E0215BD3 A524D563 6EA9A3AA D4BCF17E 843DA51E
RandomReaderImpl.class	6498EBED 2D1FE272 B73A3F79 C2B24580	EB00ACD0 29E8068E 81B43B0F 1CC7C3AB 006A6788
RandomX.class	A844DC70 D3ADB448 E4979D51 EA3C16F6	36D2EB00 A19A0DEE E645184A B5C90B5E BBE2F1E1
RandomXImpl.class	E0803AE6 FEDBFC9F FA5F7B86 A2628C1C	F635D153 A2A0BBDC F4EBE228 F344BCDF 902DCE6C
RandomXWrapper.class	E973C71F 8122B6E9 2358A469 211B92B3	A384E0FB F2FECFD6 CD437C9A 89576100 EE48E11E
RandomY.class	B6E32DF9 8179DDFD 8F5AE78E DBCC52CE	01CF65EF 42DA887A 540D1D04 1FED4F63 02762E33
ReverseTelnetDriver.class	6E1C9D66 8E50E2B7 BC5F32F8 22C34C03	A662173E 9B003891 6D11DC13 5DDB9450 0D9596D7

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File Name	MD5 Checksum	SHA-1 Checksum
ReverseTelnetInterface.class	3FDB2735 C8968310 9E1D13C8 17562DDC	092C5109 BB9EE99F 4C6FE69E 67E69865 0B5A5692
RngDriver.class	BE44D1D5 5557D5BC 29526AB4 F53C8B7A	FA00F15C 0DB2679A 2ADE699E 33D17CE7 F990517A
RngDriverException.class	AA3B758D 2C1D5616 3D2D252C 0A05906F	0DE69C9F 9FE8352B CB283F79 87BF0041 1F82E439
RngServer.class	87F7D8A7 0757B2F0 F0353544 87D0A2DE	D8301436 285FA981 B3220188 913FAC32 221C1791
SG100Driver.class	ABB646A4 0FE1F5C9 C66FEC6A 7D0B4D0A	FD6E47DA E88E2FA0 7792BA30 61625BA6 BDB6D521
AbstractGameRules.class	8F3C4CCA 06822675 F2F64B8D E7136F7F	4EB5B01E E981D6F6 3B2D97E1 B60438E8 838F4AAA
Deck.class	0D89DA50 7A68E3AA D353B207 566ADAE6	F11820BC 825483E0 2FAA6365 B0BD5DEB 34C8E290
RealShuffler.class	310359B3 B8567B0D 2B6510FA 1C010933	52D61E45 CF5FC979 3F1D0F31 95EA5DC0 14A28D61

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Playtech Casino RNG

File Name	MD5 Checksum	SHA-1 Checksum
AbstractRngClientSession.class	B51392E3 B13EF51E FEC3E6E8 56AF71E9	3E34EE59 6C6B55BF 864D6641 075D07A4 8BAD4856
BitUtils.class	DEC84208 68A531F7 DAF026A7 AAA48F88	739B3D1C 2819C9B1 1459BAF5 B89F6F5B 21A888B1
BufferLevel.class	44F4335C 2A1F21FC B3AB82B7 D0084294	BBCB3FD1 A1799097 420FA4B7 5F17C468 677E24F9
BufferLevel\$Level.class	3882C5BD 2E79238C 69FB031F 8973A8ED	12EED82A 78E5CFB8 ECA818EB 57AFB9F6 1AEB9EE4
ComPortOptionHandler.class	3EDD86CF 29BC3130 F738AAB9 76948897	F80E19AB D8A693A8 6226EC22 8F7F316E 0354F596
DriverManager.class	CA7EC7F8 A2CCDDFE 7B350CB9 299C9C0F	7F4F914B 6DD19784 1486A17B F8541902 C9F5D561
DriverManager\$1.class	61A18CB7 9228E472 B6818206 F5629164	D897D0CC AA47BE0A 5608C66C 9022C821 A643FD6E
FrequencyAnalyzer.class	53D17712 AAE3DCB8 5B748059 865F7A24	41FC4AEE 45B63A71 85C22891 DE1B30AA 91D89494
GameServerSession.class	715840CD B23AAC4B D287619C D0ED84FD	0948B125 0CCC34B8 3034BDBC FB32775A 02E786A3

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Playtech Casino RNG (continued)

File Name	MD5 Checksum	SHA-1 Checksum
IRandomBuffer.class	1D6C9576 85A0B06E 398F52A3 39DC7362	9E3F4101 6B5402EB 5E590917 5BE3147E B3CEAB7B
IRandomConsumer.class	2D6560F6 86570A51 12447F2E A6AFF966	01BE5B27 9BBB8570 1B313B51 738B8A26 CD8F348A
IRngDriver.class	566CDB40 CF5B9777 3BFB7832 0B34E39C	DE3378D4 C66BB8F5 8D26D270 F0D8381E DBF84CC6
NoiseBufferHelper.class	4BB6B749 3EF40E86 F12DFC72 8E4201D2	7E64533F F0341D94 81F8E61A C48A4D9E 835BE478
PTMetrics.class	9E489BBF D4404CA7 A10ED27B 4C9ADF53	D5AFF22A E5E50B9A C24156F8 9B0E2F3E 4CF743C1
PtTelnetClient.class	8D998F66 EA923DEF A1AC0A89 00314FD4	B196A425 2922FAF2 05EFAC2E 20E263E3 5D38A502
RandomBatch.class	17DFAF3E 737E4B74 99CFAFFB 79B8039D	089E97EA EE61B4EA CAE77849 1B385263 DB845AF4
RandomBuffer\$1.class	4FB7DA85 C89B46E7 12731292 7BA71705	918EF823 895A85F3 8E592930 BC7CB92C 791B2C5D
RandomBuffer\$2.class	1EE9380D 50C7F0BA A8D70832 B994191E	48A28D13 22676205 66E687A2 D354306B A7DCD3AD

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Playtech Casino RNG (continued)

File Name	MD5 Checksum	SHA-1 Checksum
RandomBuffer.class	CF5FD7B2 007BBEED B723FCFD FB19D3EA	B454CF42 30F84EC2 0D352CDC 6EA9DEC5 BAAC857D
RandomProvider.class	F9EE1472 8F2E4180 DC8D578B 3729EBA8	8A2956B7 1278F82B D05FEC46 02395F70 49A99DD6
RandomReader.class	2D0AF689 7E5CEF3F 651B21A7 E53279F8	E0215BD3 A524D563 6EA9A3AA D4BCF17E 843DA51E
RandomReaderImpl.class	6498EBED 2D1FE272 B73A3F79 C2B24580	EB00ACD0 29E8068E 81B43B0F 1CC7C3AB 006A6788
RandomX.class	A844DC70 D3ADB448 E4979D51 EA3C16F6	36D2EB00 A19A0DEE E645184A B5C90B5E BBE2F1E1
RandomXImpl.class	E0803AE6 FEDBFC9F FA5F7B86 A2628C1C	F635D153 A2A0BBDC F4EBE228 F344BCDF 902DCE6C
RandomXWrapper.class	E973C71F 8122B6E9 2358A469 211B92B3	A384E0FB F2FECFD6 CD437C9A 89576100 EE48E11E
RandomY.class	B6E32DF9 8179DDFD 8F5AE78E DBCC52CE	01CF65EF 42DA887A 540D1D04 1FED4F63 02762E33
ReverseTelnetDriver.class	6E1C9D66 8E50E2B7 BC5F32F8 22C34C03	A662173E 9B003891 6D11DC13 5DDB9450 0D9596D7

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File Name	MD5 Checksum	SHA-1 Checksum
ReverseTelnetInterface.class	3FDB2735 C8968310 9E1D13C8 17562DDC	092C5109 BB9EE99F 4C6FE69E 67E69865 0B5A5692
RngDriver.class	BE44D1D5 5557D5BC 29526AB4 F53C8B7A	FA00F15C 0DB2679A 2ADE699E 33D17CE7 F990517A
RngDriverException.class	AA3B758D 2C1D5616 3D2D252C 0A05906F	0DE69C9F 9FE8352B CB283F79 87BF0041 1F82E439
RngServer.class	87F7D8A7 0757B2F0 F0353544 87D0A2DE	D8301436 285FA981 B3220188 913FAC32 221C1791
SG100Driver.class	ABB646A4 0FE1F5C9 C66FEC6A 7D0B4D0A	FD6E47DA E88E2FA0 7792BA30 61625BA6 BDB6D521

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Applied Tests

Product ID	Test Performed	Reference N°	Results	Additional Details
Playtech TV RNG Playtech Bingo RNG Playtech Poker RNG Playtech Casino RNG	Random Number Generator Analysis	WI TL01_01	Pass	Internal Reference: RN-332-PTC-14-01
	Source Code Review	WI TL02_05	Pass	
	Jurisdictional Regulations Review	WI TL01_07	Pass	



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Product Characteristics

Product ID	Characteristics
Playtech TV RNG Playtech Bingo RNG Playtech Poker RNG Playtech Casino RNG	These files contain the critical files corresponding to the RNG evaluation.

Tested by: Margit de Kever
Reviewed by: Beatriz Ospina Varon

Technical Evaluation authorized by:

John van Schaijk
Technical Director



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RNG Analysis

RANDOMNESS REPORT FOR THE PLAYTECH MULTI RNG EVALUATION

The intent of this analysis is to indicate that GLI Europe B.V. (GLI) has completed its evaluation of the Playtech Multi RNG Evaluation (Random Number Generator).

SECTION I – SCOPE OF TESTING

Playtech submitted the required materials to GLI in order to conduct a Random Number Generator analysis on the Playtech Multi RNG Evaluation. The scope of this analysis was limited to software verification, source code review and data analysis. The RNG was tested for its ability to randomly produce outcomes for multiple bingo games.

SECTION II – SOURCE CODE REVIEW

Playtech submitted appropriate documentation and full source code which pertains to the generation of random numbers. GLI reviewed the source code provided by tracing the path of the RNG application from the initiation of the draw to the selected output of random numbers. GLI inspected the source code, where practicable, in an attempt to find any undisclosed switches or parameters having a possible influence on randomness and fair play. GLI assessed the ability of the RNG to produce all numbers within the desired ranges.



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RNG Analysis

SECTION III – DATA ANALYSIS

The game configuration and parameters for the data obtained and tested are listed in the tables below. GLI performed a data format check on each data set listed in order to confirm that the game parameters were correctly represented in the RNG data analyzed.

A set of numbers is said to be drawn *with replacement* if a number can be selected multiple times within the same draw. A set of numbers is said to be drawn *without replacement* if a number can only be selected once within the same draw.

Below also are listed the tests applied to each data set. For a description of the overall test methodology and a description of each test used, see *Appendix A*. The statistical testing was applied at 95%, 98% and 99% confidence levels.

SECTION III - I Bingo RNG

Data Set	Description	Range	Positions	Replacement	Draws
1	75-Ball Bingo	1-75	75	NO	59,300,000
2	80-Ball Bingo	1-80	80	NO	55,500,000
3	90-Ball Bingo	1-90	90	NO	49,100,000
4	Binary Data	0-4,294,967,295	1	N/A	3x 3,000,000

Table 1. Data Parameters

Final Outcome Distribution Test	Sets to Which Test Has Been Applied
Runs Test	1, 2, 3
Serial Correlation Test	1, 2, 3
Interplay Correlation Test	1, 2, 3
Adjacency Max-Min Test	1, 2, 3
Adjacency High-Low Test	1, 2, 3
Adjacency Blocks Test	1, 2, 3
Count of Counts Test	1, 2, 3
Coupon Collector’s Test	1, 2, 3
Duplicates Test	1, 2, 3
Overlaps Test	1, 2, 3
Permutation Test	1, 2, 3
Total Distribution Test	1, 2, 3
Total Distribution by Position Test	1, 2, 3
DIEHARD Battery of Tests ¹	4

Table 2. Tests Applied

¹Marsaglia, George. “The Marsaglia Random Number CDROM including the Diehard Battery of Tests of Randomness.” Department of Statistics and Supercomputer Computations Research Institute. 1995. Florida State University. <<http://www.stat.fsu.edu/pub/diehard/>>



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RNG Analysis

SECTION III - II Poker RNG

Data Set	Description	Range	Positions	Replacement	Draws
1	Standard 52-Card Deck	0-51	52	NO	55,000,000
2	Binary Data	0-255	1	N/A	12,000,000

Table 3. Data Parameters

Final Outcome Distribution Test	Sets to Which Test Has Been Applied
Runs Test	1
Serial Correlation Test	1
Interplay Correlation Test	1
Adjacency Max-Min Test	1
Adjacency High-Low Test	1
Adjacency Blocks Test	1
Count of Counts Test	1
Coupon Collector's Test	1
Duplicates Test	1
Overlaps Test	1
Permutation Test	1
Total Distribution Test	1
Total Distribution by Position Test	1
DIEHARD Battery of Tests ¹	2

Table 4. Tests Applied

¹ Marsaglia, George. "The Marsaglia Random Number CDROM including the Diehard Battery of Tests of Randomness." Department of Statistics and Supercomputer Computations Research Institute. 1995. Florida State University. <<http://www.stat.fsu.edu/pub/diehard/>>



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SECTION III - III Casino RNG

Data Set	Data Type	Range		# of Selections	Replacement	Samples	Result
		Minimum	Maximum				
Slot Games							
1	5-reel slot	0	7	5	YES	18,751,156	PASS
2 ②	5-reel slot	0	11	5	YES	18,749,054	PASS
3 ②	5-reel slot	0	15	5	YES	17,500,182	PASS
4 ②	5-reel slot	0	23	5	YES	18,749,348	PASS
5 ②	5-reel slot	0	31	5	YES	15,000,467	PASS
6 ②	5-reel slot	0	47	5	YES	15,000,528	PASS
7 ②	5-reel slot	0	63	5	YES	10,000,325	PASS
8 ②	5-reel slot	0	95	5	YES	30,001,456	PASS
9 ②	5-reel slot	0	127	5	YES	14,999,999	PASS
10 ②	5-reel slot	0	191	5	YES	14,999,998	PASS
11 ②	5-reel slot	0	255	5	YES	14,999,999	PASS
12 ②	9-reel slot	0	122	9	YES	32,031,356	PASS
13 ②	3-reel slot	0	19	3	YES	31,250,992	PASS
Shuffles Made through Functionality in Utils Package							
14	Utils.Shuffle (bonus)	0	2	3	NO	32,899,262	PASS
15 ②	Utils.Shuffle (bonus)	0	6	7	NO	14,029,445	PASS
16 ②③	Utils.Shuffle (bingo)	0	89	90	NO	6,838,730	PASS
Calls Made for Specific Games							
17	Pick 3	1	726	3	YES	16,666,664	PASS
18 ②	Pick 4	1	200	4	YES	18,749,999	PASS
19	Dice	1	6	3	YES	32,812,264	PASS
20 ②	Double precision floating point number	0.0 (inclusive)	1.0 (exclusive)	1	N/A ①	43,750,000	PASS
21	Bonus Selection	0	2	2	YES	49,219,627	PASS
Selection of Unique Numbers by Drawing Numbers with Replacement Till Requested Amount of Unique Numbers Is Selected							
22 ②	Shuffle	0	5	at least 6	YES	6,695,965	PASS
23 ②	Shuffle	0	17	at least 18	YES	1,565,134	PASS
24 ②	Partial Shuffle	1	48	at least 6	YES	11,831,205	PASS
25 ②	Partial Shuffle	1	80	at least 20	YES	5,470,136	PASS

Table 5. Data Parameters

- ① Not applicable, because only one selection per sample was made.
- ② For each sample multiple selections were combined into single unique values for the purpose of conducting a Poisson Distribution Test.
- ③ The Adjacency Blocks Test, Adjacency Max-Min Test, Overlaps Test and Total Distribution Test were only applied to the first half of each sample.



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SECTION III - III Casino RNG (continued)

Data Set	Data Type	Range		# of Selections	Replacement	Samples	Result
		Minimum	Maximum				
Single Numbers of Slot Bonuses, Virtual Roulette, Etc.							
26	Single Number	0	4	1	N/A ①	97,657,202	PASS
27	Single Number	0	7	1	N/A ①	93,749,036	PASS
28	Single Number	0	12	1	N/A ①	91,402,991	PASS
29	Single Number	0	15	1	N/A ①	87,499,790	PASS
30	Single Number	0	23	1	N/A ①	93,747,746	PASS
31	Single Number	0	31	1	N/A ①	74,998,727	PASS
32	Single Number	0	36	1	N/A ①	86,713,736	PASS
33	Single Number	0	63	1	N/A ①	49,992,495	PASS
34	Single Number	0	95	1	N/A ①	75,007,727	PASS
35	Single Number	0	127	1	N/A ①	50,000,000	PASS
36	Single Number	0	191	1	N/A ①	49,999,997	PASS
37	Single Number	0	255	1	N/A ①	49,999,998	PASS
38	Single Number	0	999	1	N/A ①	49,999,988	PASS
39	Single Number	0	9,999	1	N/A ①	49,999,914	PASS
Shuffled Decks (Except for Video Pokers)							
40 ②③	Shuffle	0	51	52	NO	8,410,685	PASS
41 ②③	Shuffle	0	207	208	NO	1,650,046	PASS
42 ②③	Shuffle	0	311	312	NO	1,110,063	PASS
43 ②③	Shuffle	0	415	416	NO	1,139,087	PASS
Shuffle Decks for Video Pokers (Using a Separate Scaling Method)							
44 ②③	Shuffle	0	51	52	NO	2,450,980	PASS
45 ②③	Shuffle	0	53	54	NO	2,358,490	PASS
Selecting Items without Replacement (Using Same Scaling Method As Video Pokers)							
46 ②	Draws without replacement	0	33	4	NO	6,249,999	PASS
47 ②	Draws without replacement	0	51	10	NO	2,499,999	PASS
Shuffle by Sorting Random Double Precision Floating Point Numbers							
48	Shuffle	0	2	3	NO	2,083,333	PASS
Binary Data for DIEHARD Battery of Tests							
49	Binary Data	0	255	1	N/A ①	12,000,000 ④	PASS

Table 5. Data Parameters

- ① Not applicable, because only one selection per sample was made.
- ② For each sample multiple selections were combined into single unique values for the purpose of conducting a Poisson Distribution Test.
- ③ The Adjacency Blocks Test, Adjacency Max-Min Test, Overlaps Test and Total Distribution Test were only applied to the first half of each sample.
- ④ Note three sets of data containing this sample size were obtained and analyzed.



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SECTION III - III Casino RNG (continued)

Final Outcome Distribution Test	Sets To Which Test Has Been Applied
Runs Test	1-48
Serial Correlation Test	1-48
Interplay Correlation Test	1-25, 40-48
Adjacency Blocks Test	16, 24-25, 40-47
Adjacency Max-Min Test	16, 24-25, 40-47
Adjacency High-Low Test	14-16, 22-25, 40-48
Duplicates Test	1-15, 16-19, 22, 24-25, 40-47
Horizontal Coupon Collector's Test	22-23
Overlaps Test	16, 24-25, 40-47
Permutation Test	14-16, 22-25, 40-48
Poisson Distribution Test	2-13, 15-16, 18, 20, 23-25, 38-47
Total Distribution Test	1-13, 16-21, 24-47
Total Distribution By Columns Test	1-19, 21-25, 40-48
Vertical Coupon Collector's Test	1-6, 13-15, 19-23, 26-31, 46-48
Weighted Chi Square Test	19
DIEHARD Battery of Tests ¹	49

Table 6. Tests Applied

SECTION III - IV TV RNG

Data Set	Description	Range	Positions	Replacement	Draws
1	Single Zero Roulette	0-36	1	N/A	39,000,000
2	Binary Data	0-255	1	N/A	12,000,000

Table 7. Data Parameters

Final Outcome Distribution Test	Sets to Which Test Has Been Applied
Runs Test	1
Serial Correlation Test	1
Coupon Collector's Test	1
Total Distribution Test	1
DIEHARD Battery of Tests ¹	2

Table 8. Tests Applied

¹ Marsaglia, George. "The Marsaglia Random Number CDROM including the Diehard Battery of Tests of Randomness." Department of Statistics and Supercomputer Computations Research Institute. 1995. Florida State University. <http://www.stat.fsu.edu/pub/diehard/>

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SECTION III - V Conclusion

Overall, the Playtech Multi RNG Evaluation passed the battery of tests for each configuration at the confidence levels applied.



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SECTION IV - SUMMARY

Overall Evaluation of the Random Number Generator

GLI's conclusion based upon the tests applied to the Playtech Multi RNG Evaluation data is that this Random Number Generator has exhibited random behavior and is suitable for the applications as described herein. If a game utilizes a different range or a different number of selections from the included ranges, the Playtech Multi RNG Evaluation should be resubmitted to test that set of parameters.



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APPENDIX A: Test Description

A.1 Definitions. The following terms apply to the below test descriptions. RNG output is often collected multiple numbers at a time. Each set of numbers is called a *draw*. Each individual number has a particular order within the draw. This is referred to as the number *position*.

A.2 Distribution Comparisons. Many of the tests compare an observed numerical distribution with an expected distribution. Unless otherwise specified, this is done by means of a statistical chi-square goodness-of-fit test. The value chi-square is computed in the standard way. If k is a possible value, o_k is the observed count of that value, and e_k is the expected count:

$$\chi^2 = \sum_k \frac{(o_k - e_k)^2}{e_k}$$

In the case where expected counts are too small for accurate use of the above formula, values are 'binned' together to ensure an appropriate minimum expected count. The resultant value for chi-square is compared against the distribution for the appropriate number of degrees of freedom. Unusually high (distribution mismatch) or unusually low (insufficient randomness) chi-square values can be causes for data failure.

A.3 Meta-testing. Evaluation of groups of p -values may include a meta-test for extremity of high or low p -values, a meta-test for frequency of high or low p -values, and a meta-test for uniformity of p -values, as appropriate.

A.4 Confidence Level. The statistical tests conducted by GLI are done at a particular *confidence level*. Common confidence levels used include 95%, 98% and 99%, depending on jurisdictional requirements and intended use of the RNG. High confidence level testing has low risk of mistakenly failing a good RNG, but higher risk of passing a bad RNG. Lower confidence level testing has increased power of detecting bad RNGs, while also increasing the risk of false failures of good RNGs. Specifically, the confidence level represents the probability that an ideal source of randomness would pass the testing. If an RNG passes statistical tests at a given confidence level, passage at all *higher* confidence levels is implied.

A.5 Tests. Some tests are only applicable to certain types of data. Some tests may be applied only to a portion of the data.



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Runs Test:

The Wald-Wolfowitz Runs Test is applied to each position within the draw. A center is established, typically the data median, and the number of 'runs' above and below the center are tallied. Values exactly equal to the center are discarded. This is compared to the expected distribution, which depends on the number of values above and below the center.

For example, if the numbers drawn at a particular position were

2, 3, 1, 5, 4, 7, 3, 2, 3, 2, 3, 2, 6, 7, 3, 5

and the established center were the data median of 3, the data would be parsed for runs above 3 and runs below 3.

2, 3, 1, 5, 4, 7, 3, 2, 3, 2, 3, 2, 6, 7, 3, 5

This would be counted as 4 runs.

Serial Correlation Test:

The Serial Correlation Test measures statistical correlation between consecutive draws of the same position. For each position, the sample Pearson correlation coefficient is calculated. If X represents the first number, and Y the number that follows, then the coefficient is

$$r = \frac{cov(X, Y)}{S_X S_Y}$$

where s denotes the sample standard deviation.

The coefficients are used to generate a p -value for each position.

Interplay Correlation Test:

The Interplay Correlation Test measures statistical correlation between different positions of the same draw. For each pair of positions, statistical correlation is calculated as in the Serial Correlation Test. In the case of without replacement data, an adjustment is made to account for the expected resulting negative correlation.

Adjacency Max-Min Test:

For each draw, the difference between the maximum and minimum values is calculated and recorded. This is compared with the expected theoretical distribution.

For example, if a draw consists of the numbers

2, 3, 6, 7, 4,

the resulting statistic would be 5, the difference between the maximum value of 7 and the minimum value of 2.

Adjacency High-Low Test:

For each draw, the number of local extrema ('highs' and 'lows') in the data is recorded and compared with the expected distribution. These are also referred to as 'turning points'.

For example, if a draw consists of the numbers

1, 3, 5, 7, 2, 9,

there would be one local maximum (7) and one local minimum (2). The resulting statistic would be 2.

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Adjacency Blocks Test:

For each draw, the data is first sorted. Then the amount of contiguous blocks of numbers is counted. These statistics are then compared against the expected.

For example, if a draw consists of the numbers

1, 5, 4, 2, 6, 9,

the data would be sorted and separated into blocks.

1, 2, 4, 5, 6, 9

The resulting statistic would be 3.

Coupon Collector's Test:

The Coupon Collector's Test is applied positionally. The data is parsed until all possible values have been observed, then the number of values checked is recorded and the count is restarted. This is compared with the expected distribution.

For example, if the set of all possible values is {0, 1, 2} and the first position of each draw is

1, 0, 1, 0, 2, 0, 1, 2, . . . ,

then all values are observed in the first position by the fifth draw. All values are then observed within the next 3 draws, so the first two statistics for the first position would be 5 and 3.

DieHard:

The DieHard Battery of Tests is a standard assessment of the randomness in raw outcomes generated from an RNG. The collection, designed by George Marsaglia, tests for a variety of patterns in the individual binary bits of RNG output. GLI uses a custom implementation to conduct DieHard testing.

Duplicates Test:

The Duplicates Test counts the number of times a draw is exactly duplicated in the data. In the case that a particular draw is repeated more than twice, every possible way to generate a duplicate is counted. This is compared against the theoretical distribution to verify that the number of duplicate draws falls within expected bounds.

For example, consider the dataset consisting of the following draws of two numbers each.

- a) {1, 3}
- b) {4, 1}
- c) {1, 3}
- d) {1, 3}
- e) {4, 1}
- f) {3, 1}

The duplicate pairs are (a, c), (a, d), (c, d) and (b, e) for a total of 4 duplicates. (f) is not counted as a duplicate since the draw must match in order as well as values.



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Overlaps Test:

The Overlaps Test compares consecutive draws for overlapping values. The number of overlapping values is recorded for each pair of draws. This observed distribution of overlaps is then compared against the expected distribution.

For example, if the following draws are observed consecutively,

- a) {1, 4, 5, 6}
- b) {4, 1, 7, 6}

the number of overlaps would be 3, representing the values 1, 4 and 6.

Permutation Test:

The Permutation Test is a test applicable to data that represents a reordering of numbers. Each draw can be considered as a permutation of the original ordering. Every permutation can be decomposed into disjoint cycles, which represent the possible positions a number would occupy if the same permutation is applied repeatedly.

For each draw, three statistics are collected based on the cycle decomposition:

- The number of cycles.
- The size of the smallest cycle.
- The size of the largest cycle.

Each of these statistics generates a distribution of observations which are compared with their respective expected distributions.

For example, if the following draw were observed as a reordering of the numbers from 1 to 6,

1, 3, 5, 4, 2, 6

the cyclic decomposition would be (1) (2 3 5) (4) (6). 1, 4, and 6 remain in their original positions, so they form their own cycles.

The values 2, 3, and 5 are shuffled, so they form a single cycle together. The total number of cycles is 4, the smallest cycle has size 1, and the largest cycle has size 3.

Count of Counts Test:

The Count of Counts Test first counts the occurrences of each value in each position of the data. These counts are then tallied and compared with the expected distribution of counts for the draw size and range of values.

Total Distribution Test:

The Total Distribution Test is a simple tally of all observed values throughout the data. This is compared with the expected distribution. Typically the expected distribution is a uniform distribution. In the case of unequal weighting of values, an appropriate discrete distribution is used.

Total Distribution by Position Test:

The Total Distribution by Position Test tallies the observed distribution of values for each position within the draw. Each of these distributions is then compared with the expected.



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