Gaming Laboratories International
RNG Revised Report

Report N°	2016PTC674RNG00_1
Date	17 June 2016

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GLI Africa
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GLI Austria GmbH
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GLI Italy
GLI South America

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:*** Alderney - Technical Standards and Guidelines Version 4.1. ***Bulgaria Online***: General technical and functional requirements to gaming software and communication equipment of remote gambling games; Act on Gambling. Prom. SG. 26/30 Mar 2012 in force from 01.07. ***Denmark Online:*** Spillemyndigheden's Certification Programme - General requirements - SCP.00.00.EN.1.0; Spillemyndigheden's Certification Programme - Testing Standards for Online Casino - SCP.01.03.EN.1.0; Spillemyndigheden's Certification Programme - Inspection Standards for Online Casino - SCP.02.03.EN.1.0. ***France - Online:*** 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; Annex to the Technical Requirements File Version 1.2 of 23rd March 2012; Gambling Commissioner's Guidelines - v.1.1.0. ***Gibraltar:*** Remote Technical and Operating Standards for the Gibraltar Gambling Industry; Gambling Commissioner's Guidelines - v.1.1.0; Gambling Act 2005 - Act. No. 2005-72 Commencement (LN. 2006/114) except for s. 55(b) 26.10.2006 Assent 22.12.2005. ***GLI-19:*** Interactive Gaming Systems V2.0. ***Isle of Man:*** Gambling Supervision Commission's Statutory Document Number 731/07 Online; Gambling (Systems Verification) (No.2) Regulations 2007, laid before Tynwald 16th October 2007, coming into operation 31st August 2007. ***Italy - Online:*** Decree of the Director General of the Autonomous Administration of State Monopolies (AAMS) on the 10th of January 2011 and published under G.U. n. 27 on the 3rd of February 2011. ***Malta Online:*** Remote Gaming Regulations (SUBSIDIARY LEGISLATION 438.04), Third Schedule – Technical Requirements for Gaming System. LEGAL NOTICE 176 of 2004, as amended by Legal Notices 110 of 2006, 270 and 426 of 2007, and 90 of 2011. ***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 nº 13/2011 of 27 May. ***Romania Online*:** DECISION amending the methodological norms of applying the Government emergency ordinance no. 77/2009 on the organization and operation of games of chance and amending and supplementing Government Decision no. 298/2013 on the organization and functioning of the National Office for Games of Chance, amending Government Decision no. 870/2009, approving the Methodological Norms for the application of Government emergency ordinance no. 77/2009 and repealing Government Decision no. 870/2009 on the organization and operation of games of chance. ***UK Remote***: Remote Gambling and Software Technical Standards (July 2015); Testing Strategy for Compliance with Remote Gambling and Software Technical Standards – First (Published August 2009 – Updated July 2015).
Jurisdiction	Non-Jurisdictional

Internal Reference: RN-400-PTC-16-01, RN-332-PTC-14-01-337

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Manufacturer	Playtech Software Limited 2nd Floor, St George's Court Upper Church Street Douglas Isle of Man, IM1 1EE
Submitter	Playtech Software Limited 2nd Floor, St George's Court Upper Church Street Douglas Isle of Man, IM1 1EE
Product Name	**Playtech Multi RNG 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. As requested per manufacturer's letter received 9th February 2016.
Evaluation Period	17th March 2016 / 5th April 2016
Result	Pass (See Comments and Conditions on page 3)
Sections	- Comments/Conditions - Hardware Product Details - Software Product Details - Applied Tests - Product Characteristics - RNG Analysis - Terms and Conditions

Comments/Conditions

Comments

This Revised Report replaces Evaluation Report 2016PTC674RNG00, dated 8th April 2016.
This Revised Report was issued in order to:

- Include Romania Online within the scope of testing.
- Update the Software Product Details on pages 7 through 9 and 11 through 13.

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 Verify+ by Kobetron™ was used to generate the CDCK, 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.

Hardware Product Details

There are no Hardware Product Details applicable to this Report.

Software Product Details

Playtech TV RNG

File Name	CDCK	MD5 Signature	SHA-1 Signature
ENG_ROULETTE.pm	C4BC	34E9B3EF 7E8880D7 2B5C86B8 F296B8C7	212721F7 1E72C4CD 3E4EBA38 659BBE0E 09D48834
random.pm	ADDD	63274FE1 AED17EE5 A4CCB1AA DC48C257	70C7FBB3 A9353E55 6FD2D856 58116684 B1847ABC
roulette_spots.pm	BDE4	67B5AF3C C5EDBC1E B45E34C1 83BFA352	A71EC5B9 5986A27A E523B078 498F1F07 0A13DE7A

Playtech Bingo RNG

File Name	CDCK	MD5 Signature	SHA-1 Signature
rng.properties	40A0	4FBA6E0A 683B8584 0D47B396 CA392AE1	9A2E6B48 C4E5CD6B CCDBE5CF CCD9D34A 95BDCD26
AccessCountRNGCyclingStrategy.class	FB6C	8C40A603 6A3A72EB 16B72162 6284D913	B95EFC98 19232608 C216AD02 836F7A0A E92F7E7C
DefaultRNG.class	42D9	9A785B34 752455A7 AF2B89E2 789A1E9E	2C2AC97C 0D5529F4 C3158733 9590E8D2 533E1264
DefaultSecureRandom.class	2576	2A3E69FC BD6ADFB2 FE884654 F0B16D15	2C42D303 35D61CF2 9EB22219 BA1F2E63 CA24A4C1
RandomException.class	0831	8036871F 0CF547FB 355E74E6 91ABD848	832FEAD9 C7259793 205AED51 FB503DBC EC29F25B

Software Product Details

Playtech Bingo RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
RandomNumberGenerator.class	8033	CFF53ABA 28F502B1 08EABBB8 17C6FF1B	B68292AB 0021A39B C03B0434 E173554E DC30C83E
RandomUtils.class	FF4C	E18F7B3E 5D45153A E37EE414 5080AA4C	DBAA4C48 0EAB4B6E 68D1158E 8D24255B 345072E4
RNGCyclingStrategy.class	5D08	30FE862C 5371F5F1 933F62DB CA48B6B4	BE43474B B9167780 CFE1A79E DE3A11C1 FFC17B6B
SecureRandomWrapper.class	2AF8	45DCA241 D5EB7542 03A4B59F F8D6C420	2D4EAED6 642949F1 FB4D421B 60998B99 D5B22996
SpecificSecureRandom.class	4A7F	6E724E42 1FA0457C 0948DEDB B165AD9B	5EC46AFD 00F221C5 5E48171D 80B8B029 DC9D2956
SunSHA1PRNGSecureRandom.class	AABA	4B95CB9A 70F199ED 5F31FCB8 A16A3C5B	53C5C7EC FEB8B8D3 69051756 84501655 CA813A10
TimedAccessRNGCyclingStrategy.class	BA1C	59CEA88E F795D21D DDB70DBB 5E214F96	F7CE7A1F A8CD0C55 5CB8F3A4 F5A408B6 7E61E4D8
RNGFactoryBean.class	7B03	ED52889C 3C66695F 55196ABC 875C32B8	68DA7423 8AA08FEA CE215DDC 7ED8C79B CD762BF5

Software Product Details

Playtech Poker RNG

File Name	CDCK	MD5 Signature	SHA-1 Signature
AbstractRngClientSession.class (Version 16.4.0.89)	18FD	BA39C4DE 2665FD3C DAC42576 153A8ADD	701DFF10 AD8AE4F8 F664A0D5 F3EB7982 7B57B2F1
BitUtils.class (Version 16.4.0.89)	80CE	D087F556 D1FB3B94 0BE2404E 26E9338E	68BC68C5 EF4B6313 D469F1AE A3BF2DFC 712AB68F
ComPortOptionHandler.class (Version 16.4.0.89)	3536	D5282AC4 CF54446E 1D7A3982 33E20114	4BF125F6 17E311A2 B37F9A34 83334EAC FB62FB5D
DriverManager.class (Version 16.4.0.89)	37DF	E232E5A1 D8E57994 FCA5F958 308A00BE	72BEBA31 578F74E2 1F9569BD C097C04A 8B362223
DriverManager$1.class (Version 16.4.0.89)	8810	8B3AC5F7 6EDD1B02 AF78302E 86B43AC2	29D6191D A4394440 E9186326 5FE86BF9 2A7EE464
FrequencyAnalyzer.class (Version 16.4.0.89)	F7A9	58A36FBA 6F799FE3 094E375F B313C3A9	8013D639 EF46A4E5 BD904DDF EB80D721 E0E782DC
GameServerSession.class (Version 16.4.0.89)	2706	01E8864D A057413A 1CEA8C91 234ED5DC	96678F10 2AD74FA9 B004287E 4A14D6D1 3B9E12C9

Software Product Details

Playtech Poker RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
IRandomConsumer.class (Version 16.4.0.89)	298E	CDD6FE97 3B196F22 9B3A6D45 820DD53F	BD02A93B 0B43496F 53CA7C2B 169DF4FE BAA28B28
IRngDriver.class (Version 16.4.0.89)	966A	D021A021 6ECDBE59 B5A1FF46 A506F998	178809EB 7A6E2699 BEFD1684 EE516605 43483AF1
NoiseBufferHelper.class (Version 16.4.0.89)	C866	F44CB136 5738F1A0 29EB5F4D 04349DD9	78F396B5 A8099967 95440A0C F1BCE048 1DDCD6C6
PtTelnetClient.class (Version 16.4.0.89)	67BA	A4EC9D5E DFA0AC27 AA2927B6 AFC1F8C5	D45FB9D4 AA0C6D7E 0AFE2A89 FFD31EDA AFE24CA7
RandomBatch.class (Version 16.4.0.89)	4824	6B9498C7 124E73AE C01E0295 5D1E119A	C051D26E 7D14129C 24229C59 BAC513EB E95397AC
RandomBuffer$1.class (Version 16.4.0.89)	4154	CE9D1023 6FC3FA67 B82B30AA E378B254	31CCADE0 5DC8466C D5A66D9B E7E08C2A 4687E764
RandomBuffer$2.class (Version 16.4.0.89)	2D11	E813CA00 1865B500 49FDBD5F 40DB593D	CCA9F5BE EA9932E3 785AD355 02B6D619 8FEF831D

Software Product Details

Playtech Poker RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
RandomBuffer.class (Version 16.4.0.89)	64FB	332BF682 4A5C4431 BEF91F4E 756E69CB	2A1EB458 EBA18045 5491BF99 FA2E1925 4583379E
RandomProvider.class (Version 16.4.0.89)	BE81	07BC5306 84D2D494 2E9A43E6 916AF125	E906B50C F21DC9DF 87670528 7E1D0383 5B1A01C0
RandomXImpl.class (Version 16.4.0.89)	C1E1	51A8B008 669A2FE6 740BD0AB 3F5949C9	990A6638 A9C1F815 9D0F88F5 B28E146F 67F016A6
RandomXWrapper.class (Version 16.4.0.89)	E517	234C8117 6515817F DDC5B15F 8BF3C221	04B111D9 43D101E6 FFC4152F C28BE64A A2BEF590
RandomY.class (Version 16.4.0.89)	C232	09980716 6DFADD10 5F07F88F B6B9EA53	2C686645 0C634CA4 57C7379B 039D1EF3 0E025DDF
ReverseTelnetDriver.class (Version 16.4.0.89)	64E2	468A3CB2 46898BA1 EAC4F972 2D7E6ED8	965CFD28 31865B47 148FB72A C8EA713E 8BC21A66

Software Product Details

Playtech Poker RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
ReverseTelnetInterface.class (Version 16.4.0.89)	BD98	48C5F1E8 F81A5059 DCE330B3 64FB13A0	B4916A80 82B6CA71 3E88E6BC 88C54543 BB350F24
RngDriver.class (Version 16.4.0.89)	5080	0041B0DF 8354C130 C52CABBF 8F252917	EA355440 8E5CCC7E 62D4D164 8A77193B 205D12EF
RngDriverException.class (Version 16.4.0.89)	A1C1	D0BCE660 F890AEDC F1A75759 4DB0AA95	B6359F2B 897BB87E C003724A 7F854A47 4166E806
RngServer.class (Version 16.4.0.89)	63DD	85537AD1 74BE53F5 B8A45A88 450C1CC6	915392A8 B6ED68C1 483E3497 214F6B30 272ED99C
SG100Driver.class (Version 16.4.0.89)	72AF	9530ADDE 1B52F832 FCA5F4F6 94553A2C	4AC229D8 82AA587B A11F326B E9B1F579 1DCEC864
AbstractGameRules.class*	C4EC	97A2AB11 B394FAC3 DC5BAF5B 68B95EA5	D049A8D3 7116381B 698F2E2A 80F74E93 1EAC4D23
Deck.class*	F622	1C694A2A ADD69650 3A750FD1 9C221B61	AC77B318 898562EE BDA830CF CAFF9D0F 9A4D8362
RealShuffler.class*	1974	3F5D35FE B35FF445 D931D55A F8020642	D8A26416 CF77C1C5 FB672561 244B2AB4 13180895

*These files were taken from the Poker Game Server.

Software Product Details

Playtech Casino RNG

File Name	CDCK	MD5 Signature	SHA-1 Signature
AbstractRngClientSession.class (Version 16.4.0.89)	18FD	BA39C4DE 2665FD3C DAC42576 153A8ADD	701DFF10 AD8AE4F8 F664A0D5 F3EB7982 7B57B2F1
BitUtils.class (Version 16.4.0.89)	80CE	D087F556 D1FB3B94 0BE2404E 26E9338E	68BC68C5 EF4B6313 D469F1AE A3BF2DFC 712AB68F
ComPortOptionHandler.class (Version 16.4.0.89)	3536	D5282AC4 CF54446E 1D7A3982 33E20114	4BF125F6 17E311A2 B37F9A34 83334EAC FB62FB5D
DriverManager.class (Version 16.4.0.89)	37DF	E232E5A1 D8E57994F CA5F9583 08A00BE	72BEBA31 578F74E2 1F9569BD C097C04A 8B362223
DriverManager$1.class (Version 16.4.0.89)	8810	8B3AC5F7 6EDD1B02 AF78302E 86B43AC2	29D6191D A4394440 E9186326 5FE86BF9 2A7EE464
FrequencyAnalyzer.class (Version 16.4.0.89)	F7A9	58A36FBA 6F799FE3 094E375F B313C3A9	8013D639 EF46A4E5 BD904DDF EB80D721 E0E782DC
GameServerSession.class (Version 16.4.0.89)	2706	01E8864D A057413A 1CEA8C91 234ED5DC	96678F10 2AD74FA9 B004287E 4A14D6D1 3B9E12C9

Software Product Details

Playtech Casino RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
IRandomConsumer.class (Version 16.4.0.89)	298E	CDD6FE97 3B196F22 9B3A6D45 820DD53F	BD02A93B 0B43496F 53CA7C2B 169DF4FE BAA28B28
IRngDriver.class (Version 16.4.0.89)	966A	D021A021 6ECDBE59 B5A1FF46 A506F998	178809EB 7A6E2699 BEFD1684 EE516605 43483AF1
NoiseBufferHelper.class (Version 16.4.0.89)	C866	F44CB136 5738F1A0 29EB5F4D 04349DD9	78F396B5 A8099967 95440A0C F1BCE048 1DDCD6C6
PtTelnetClient.class (Version 16.4.0.89)	67BA	A4EC9D5E DFA0AC27 AA2927B6 AFC1F8C5	D45FB9D4 AA0C6D7E 0AFE2A89 FFD31EDA AFE24CA7
RandomBatch.class (Version 16.4.0.89)	4824	6B9498C7 124E73AE C01E0295 5D1E119A	C051D26E 7D14129C 24229C59 BAC513EB E95397AC
RandomBuffer$1.class (Version 16.4.0.89)	4154	CE9D1023 6FC3FA67 B82B30AA E378B254	31CCADE0 5DC8466C D5A66D9B E7E08C2A 4687E764
RandomBuffer$2.class (Version 16.4.0.89)	2D11	E813CA00 1865B500 49FDBD5F 40DB593D	CCA9F5BE EA9932E3 785AD355 02B6D619 8FEF831D

Software Product Details

PlaytechCasino RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
RandomBuffer.class (Version 16.4.0.89)	64FB	332BF682 4A5C4431 BEF91F4E 756E69CB	2A1EB458 EBA18045 5491BF99 FA2E1925 4583379E
RandomProvider.class (Version 16.4.0.89)	BE81	07BC5306 84D2D494 2E9A43E6 916AF125	E906B50C F21DC9DF 87670528 7E1D0383 5B1A01C0
RandomXImpl.class (Version 16.4.0.89)	C1E1	51A8B008 669A2FE6 740BD0AB 3F5949C9	990A6638 A9C1F815 9D0F88F5 B28E146F 67F016A6
RandomXWrapper.class (Version 16.4.0.89)	E517	234C8117 6515817F DDC5B15F 8BF3C221	04B111D9 43D101E6 FFC4152F C28BE64A A2BEF590
RandomY.class (Version 16.4.0.89)	C232	09980716 6DFADD10 5F07F88F B6B9EA53	2C686645 0C634CA4 57C7379B 039D1EF3 0E025DDF
ReverseTelnetDriver.class (Version 16.4.0.89)	64E2	468A3CB2 46898BA1 EAC4F972 2D7E6ED8	965CFD28 31865B47 148FB72A C8EA713E 8BC21A66

Software Product Details

Playtech Casino RNG (continued)

File Name	CDCK	MD5 Signature	SHA-1 Signature
ReverseTelnetInterface.class (Version 16.4.0.89)	BD98	48C5F1E8 F81A5059 DCE330B3 64FB13A0	B4916A80 82B6CA71 3E88E6BC 88C54543 BB350F24
RngDriver.class (Version 16.4.0.89)	5080	0041B0DF 8354C130 C52CABBF 8F252917	EA355440 8E5CCC7E 62D4D164 8A77193B 205D12EF
RngDriverException.class (Version 16.4.0.89)	A1C1	D0BCE660 F890AEDC F1A75759 4DB0AA95	B6359F2B 897BB87E C003724A 7F854A47 4166E806
RngServer.class (Version 16.4.0.89)	63DD	85537AD1 74BE53F5 B8A45A88 450C1CC6	915392A8 B6ED68C1 483E3497 214F6B30 272ED99C
SG100Driver.class (Version 16.4.0.89)	72AF	9530ADDE 1B52F832 FCA5F4F6 94553A2C	4AC229D8 82AA587B A11F326B E9B1F579 1DCEC864

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-MA-006	Pass	Internal Reference: RN-400-PTC-16-01 RN-332-PTC-14-01-337
	Source Code Review	WI-MA-006	Pass	
	Jurisdictional Regulations Review	WI-MA-006	Pass	

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: Joost van ‘t Schip
Reviewed by: Margit de Kever

Technical Evaluation authorized by:

John van Schaijk
Technical Director

RNG Analysis

RANDOMNESS REPORT FOR THE PLAYTECH MULTI RNG EVALUATION

The intent of this report 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 Multi RNG. 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 Bingo, Poker, Casino and TV games.
The Multi RNG was evaluated against the RNG-specific requirements of the following technical standards:

- ***AGCC*** - Alderney - Technical Standards and Guidelines Version 4.1
- ***Bulgaria*** - General technical and functional requirements to gaming software and communication equipment of remote gambling games; Act on Gambling. Prom. SG. 26/30 Mar 2012 in force from 01.07.
- ***Denmark Online:*** Spillemyndigheden's Certification Programme - General requirements - SCP.00.00.EN.1.0; Spillemyndigheden's Certification Programme - Testing Standards for Online Casino - SCP.01.03.EN.1.0; Spillemyndigheden's Certification Programme - Inspection Standards for Online Casino - SCP.02.03.EN.1.0.
- ***France - Online:*** 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; Annex to the Technical Requirements File Version 1.2 of 23rd March 2012; Gambling Commissioner's Guidelines - v.1.1.0.
- ***Gibraltar:*** Remote Technical and Operating Standards for the Gibraltar Gambling Industry; Gambling Commissioner's Guidelines - v.1.1.0; Gambling Act 2005 - Act. No. 2005-72 Commencement (LN. 2006/114), except for s. 55(b) 26.10.2006 Assent 22.12.2005.
- ***GLI-19*** *Interactive Gaming Systems V2.0.*
- ***Isle of Man:*** Gambling Supervision Commission's Statutory Document Number 731/07 Online; Gambling (Systems Verification) (No.2) Regulations 2007, laid before Tynwald 16th October 2007, coming into operation 31st August 2007.
- ***Italy - Online:*** Decree of the Director General of the Autonomous Administration of State Monopolies (AAMS) on the 10th of January 2011 and published under G.U. n. 27 on the 3rd of February 2011.
- ***Malta Online:*** Remote Gaming Regulations (SUBSIDIARY LEGISLATION 438.04), Third Schedule - Technical Requirements for Gaming System; LEGAL NOTICE 176 of 2004, as amended by Legal Notices 110 of 2006,270 and 426 of 2007, and 90 of 2011.
- ***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 nº 13/2011 of 27 May.
- ***Romania Online:*** DECISION amending the methodological norms of applying the Government emergency ordinance no. 77/2009 on the organization and operation of games of chance and amending and supplementing Government Decision no. 298/2013 on the organization and functioning of the National Office for Games of Chance, amending Government Decision no. 870/2009, approving the Methodological Norms for the application of Government emergency ordinance no. 77/2009 and repealing Government Decision no. 870/2009 on the organization and operation of games of chance.
- ***UK Remote***: Remote Gambling and Software Technical Standards (July 2015); Testing Strategy for Compliance with Remote Gambling and Software Technical Standards - First (Published August 2009 – Updated July 2015)

SECTION II – SOURCE CODE REVIEW

Playtech submitted appropriate documentation and partial 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 range.

Internal Reference: RN-400-PTC-16-01, RN-332-PTC-14-01-337

RNG Analysis

SECTION III – DATA ANALYSIS

The game configuration and parameters for the data obtained and tested are listed in the tables below. Please note that this data has already been tested in a previous submission. 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 Parameters:

Number	Data Set	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

SECTION III - II Poker RNG

Data Parameters:

Number	Data Set	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

RNG Analysis

SECTION III – DATA ANALYSIS

SECTION III - III Casino RNG

Data Parameters:

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

RNG Analysis

SECTION III – DATA ANALYSIS

SECTION III - III Casino RNG (continued)

Data Parameters:

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

SECTION III - IV TV RNG

Data Parameters:

Number	Data Set	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

Internal Reference: RN-400-PTC-16-01, RN-332-PTC-14-01-337

RNG Analysis

SECTION III – DATA ANALYSIS

SECTION III - V Conclusion

For a summary of the statistical tests applied to each data set, see *Appendix A*. For a description of the overall test methodology and a description of each test used, see *Appendix B*.
Overall, the RNG passed the battery of tests for each configuration at the 95%, 98%, and 99% confidence levels.

SECTION IV - SUMMARY

Overall Evaluation of the Random Number Generator
GLI's conclusion based upon the tests applied to the Multi RNG 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 RNG should be resubmitted to test that set of parameters.

RNG Analysis

APPENDIX A: Statistical Test Summary

Data Set	Range	Data type	Positions	Replacement	Draws	Runs	Serial Corr.	Interplay Corr.	Adj. Blcoks	Adj. Max-Min	Adj. High-Low	Duplicates	(Hori.) Coupon Collector	Overlaps	Permutation	Tot.Dist.	Tot. Dist. By Position	(Vert.) Coupon Collector	Count of Counts	Unequal Probabilities	DIEHARD Battery of Tests
Bingo RNG																					
1	1-75	75-ball Bingo	75	NO	59,300,000	X	X	X	X	X	X	X		X	X	X	X	X	X		
2	1-80	80-ball Bingo	80	NO	55,500,000	X	X	X	X	X	X	X		X	X	X	X	X	X		
3	1-90	90-ball Bingo	90	NO	49,100,000	X	X	X	X	X	X	X		X	X	X	X	X	X		
4	0-4,294,967,295	Binary Data	1	N/A	3x 3,000,000																X

Data Set	Range	Data type	Positions	Replacement	Draws	Runs	Serial Corr.	Interplay Corr.	Adj. Blcoks	Adj. Max-Min	Adj. High-Low	Duplicates	(Hori.) Coupon Collector	Overlaps	Permutation	Tot.Dist.	Tot. Dist. By Position	(Vert.) Coupon Collector	Count of Counts	Unequal Probabilities	DIEHARD Battery of Tests
Poker RNG																					
1	0-51	Standard 52-Card Deck	52	NO	55,000,000	X	X	X	X	X	X	X		X	X	X	X	X	X		
2	0-255	Binary Data	1	N/A	12,000,000																X

Internal Reference: RN-400-PTC-16-01, RN-332-PTC-14-01-337

RNG Analysis

APPENDIX A: Statistical Test Summary

Data Set	Range	Data type	Positions	Replacement	Draws	Runs	Serial Corr.	Interplay Corr.	Adj. Blcoks	Adj. Max-Min	Adj. High-Low	Duplicates	(Hori.) Coupon Collector	Overlaps	Permutation	Tot.Dist.	Tot. Dist. By Position	(Vert.) Coupon Collector	Count of Counts	Unequal Probabilities	DIEHARD Battery of Tests
Casino RNG																					
1	0-7	5-reel slot	5	YES	18,751,156	X	X	X				X				X	X	X			
2	0-11	5-reel slot	5	YES	18,749,054	X	X	X				X				X	X	X	X		
3	0-15	5-reel slot	5	YES	17,500,182	X	X	X				X				X	X	X	X		
4	0-23	5-reel slot	5	YES	18,749,348	X	X	X				X				X	X	X	X		
5	0-31	5-reel slot	5	YES	15,000,467	X	X	X				X				X	X	X	X		
6	0-47	5-reel slot	5	YES	15,000,528	X	X	X				X				X	X	X	X		
7	0-63	5-reel slot	5	YES	10,000,325	X	X	X				X				X	X		X		
8	0-95	5-reel slot	5	YES	30,001,456	X	X	X				X				X	X		X		
9	0-127	5-reel slot	5	YES	14,999,999	X	X	X				X				X	X		X		
10	0-191	5-reel slot	5	YES	14,999,998	X	X	X				X				X	X		X		
11	0-255	5-reel slot	5	YES	14,999,999	X	X	X				X				X	X		X		
12	0-122	9-reel slot	9	YES	32,031,356	X	X	X				X				X	X		X		
13	0-19	3-reel slot	3	YES	31,250,992	X	X	X				X				X	X	X	X		
14	0-2	Utils.Shuffle (bonus)	3	NO	32,899,262	X	X	X			X	X			X		X	X			
15	0-6	Utils.Shuffle (bonus)	7	NO	14,029,445	X	X	X			X	X			X		X	X	X		
16	0-89	Utils.Shuffle (bingo)	90	NO	6,838,730	X	X	X	X	X	X	X		X	X	X	X		X		
17	1-726	Pick 3	3	YES	16,666,664	X	X	X				X				X	X				
18	1-200	Pick 4	4	YES	18,749,999	X	X	X				X				X	X		X		
19	1-6	Dice	3	YES	32,812,264	X	X	X				X				X	X	X		X	
20	0.0(inclusive)-1.0(exclusive)	Double precision floating point number	1	N/A	43,750,000	X	X	X								X		X	X		
21	0-2	Bonus Selection	2	YES	49,219,627	X	X	X								X	X	X			
22	0-5	Shuffle	At least 6	YES	6,695,965	X	X	X			X	X	X		X		X	X			
23	0-17	Shuffle	At least 18	YES	1,565,134	X	X	X			X		X		X		X	X	X		
24	1-48	Partial Shuffle	At least 6	YES	11,831,205	X	X	X	X	X	X	X		X	X	X	X		X		
25	1-80	Partial Shuffle	At least 20	YES	5,470,136	X	X	X	X	X	X	X		X	X	X	X		X		
26	0-4	Single Number	1	N/A	97,657,202	X	X									X		X			
27	0-7	Single Number	1	N/A	93,749,036	X	X									X		X			
28	0-12	Single Number	1	N/A	91,402,991	X	X									X		X			
29	0-15	Single Number	1	N/A	87,499,790	X	X									X		X			
30	0-23	Single Number	1	N/A	93,747,746	X	X									X		X			
31	0-31	Single Number	1	N/A	74,998,727	X	X									X		X			
32	0-36	Single Number	1	N/A	86,713,736	X	X									X					

Internal Reference: RN-400-PTC-16-01, RN-332-PTC-14-01-337

RNG Analysis

APPENDIX A: Statistical Test Summary

Data Set	Range	Data type	Positions	Replacement	Draws	Runs	Serial Corr.	Interplay Corr.	Adj. Blcoks	Adj. Max-Min	Adj. High-Low	Duplicates	(Hori.) Coupon Collector	Overlaps	Permutation	Tot.Dist.	Tot. Dist. By Position	(Vert.) Coupon Collector	Count of Counts	Unequal Probabilities	DIEHARD Battery of Tests
Casino RNG																					
33	0-63	Single Number	1	N/A	49,992,495	X	X									X					
34	0-95	Single Number	1	N/A	75,007,727	X	X									X					
35	0-127	Single Number	1	N/A	50,000,000	X	X									X					
36	0-191	Single Number	1	N/A	49,999,997	X	X									X					
37	0-255	Single Number	1	N/A	49,999,998	X	X									X					
38	0-999	Single Number	1	N/A	49,999,988	X	X									X			X		
39	0-9,999	Single Number	1	N/A	49,999,914	X	X									X			X		
40	0-51	Shuffle	52	NO	8,410,685	X	X	X	X	X	X	X		X	X	X	X		X		
41	0-207	Shuffle	208	NO	1,650,046	X	X	X	X	X	X	X		X	X	X	X		X		
42	0-311	Shuffle	312	NO	1,110,063	X	X	X	X	X	X	X		X	X	X	X		X		
43	0-415	Shuffle	416	NO	1,139,087	X	X	X	X	X	X	X		X	X	X	X		X		
44	0-51	Shuffle	52	NO	2,450,980	X	X	X	X	X	X	X		X	X	X	X		X		
45	0-53	Shuffle	54	NO	2,358,490	X	X	X	X	X	X	X		X	X	X	X		X		
46	0-33	Draws without replacement	4	NO	6,249,999	X	X	X	X	X	X	X		X	X	X	X	X	X		
47	0-51	Draws without replacement	10	NO	2,499,999	X	X	X	X	X	X	X		X	X	X	X	X	X		
48	0-2	Shuffle	3	NO	2,083,333	X	X	X			X				X		X	X			
49	0-255	Binary Data	1	N/A	12,000,000																X

Data Set	Range	Data type	Positions	Replacement	Draws	Runs	Serial Corr.	Interplay Corr.	Adj. Blcoks	Adj. Max-Min	Adj. High-Low	Duplicates	(Hori.) Coupon Collector	Overlaps	Permutation	Tot.Dist.	Tot. Dist. By Position	(Vert.) Coupon Collector	Count of Counts	Unequal Probabilities	DIEHARD Battery of Tests
TV RNG																					
1	0-36	Single Zero Roulette	1	N/A	39,000,000	X	X									X		X			
2	0-255	Binary Data	1	N/A	12,000,000																X

Internal Reference: RN-400-PTC-16-01, RN-332-PTC-14-01-337

RNG Analysis

APPENDIX B: Test Description

B.1 **Definitions.** The following terms apply to the below test descriptions. Randomness Device or Random Number Generator (RNG) output may be 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.*

B.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.

B.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.

B.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.

B.5 **Tests**. Some tests are only applicable to certain types of data. Some tests may be applied only to a portion of the data. Some tests may require that the data be parsed, binned, or otherwise transformed, as necessitated by data format.

RNG Analysis

APPENDIX B: Test Description

Adjacency Blocks:
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. The resulting statistic would be 3.

Adjacency High-Low:
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.

Adjacency Max-Min:
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 (7) and the minimum value (2).

Count of Counts (Poisson):
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.

Duplicates:
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.

$$\begin{array}{l} a)\ 1, 3 \\ b)\ 4, 1 \\ c)\ 1, 3 \\ d)\ 1, 3 \\ e)\ 4, 1 \\ f)\ 3, 1 \end{array}$$

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.

RNG Analysis

APPENDIX B: Test Description

Interplay Correlation:
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.

Overlaps:
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.

Coupon Collector's:
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

$$1, 0, 1, 0, 2, 0, 1, 2, \ldots$$

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.

Permutation:
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). 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.

RNG Analysis

APPENDIX B: Test Description

Runs:
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.

$$\underbrace{2, 3, 1}, \overbrace{5, 4, 7, 3}, \underbrace{2, 3, 2, 3, 2}, \overbrace{6, 7, 3, 5}$$

This would be counted as 4 runs.

Serial Correlation:
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.

Total Distribution:
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:
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.

Unequal Probabilities Test:
The Unequal Probabilities Test is a test applicable to multi-value draws whose results are sorted. The frequency of occurrence of each value is tallied for each position in the sorted draw. The expected frequency is calculated, taking the sorted nature of the data into account. The expected and observed frequency distributions are compared for each position.

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.

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