



## Poker Cards Analysis – March 2024

### The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for Poker games for the period **March 01, 2024** to **March 31, 2024** as recorded by the respective game servers and analyzed the Poker cards for statistical randomness. The results of the analysis are given below.

For details on the gaming sites serviced by the Entain Plc game servers and used in this audit refer to the [List](#).

### 1. Poker hand types statistics

These calculations were done for Royal Flush, Straight Flush, Four of a Kind, Full House, Flush, Straight, 3 of a Kind, 2 pairs, 1 Pair, High Card.

The Poker hand types analysis involved creating subsets of data and conducting Chi-square tests on each subset.

The null hypothesis for the chi-square test is that the observed frequencies of each type of hand matches the theoretical values for a deck that has been shuffled using a perfect random number generator. The p-values observed in these multiple tests are expected to follow a uniform distribution for the range 0.0 to 1.0.

The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Poker hand types statistics tests.

#### 1.1 Poker hand types statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	9	5.25	0.81216
2	9	15.34	0.08199
3	9	8.71	0.46430
4	9	5.50	0.78916
5	9	14.92	0.09302
6	9	10.90	0.28229
7	9	9.00	0.43758
8	9	6.25	0.71492
9	9	6.59	0.67946
10	9	9.40	0.40094
11	9	5.59	0.78001
12	9	8.55	0.48016
13	9	5.72	0.76737
14	9	15.80	0.07112
15	9	9.87	0.36096
16	9	7.57	0.57777
17	9	10.12	0.34080
18	9	6.54	0.68492
19	9	5.29	0.80841
20	9	7.89	0.54489
21	9	6.61	0.67736
22	9	10.55	0.30763
23	9	10.20	0.33420
24	9	9.31	0.40883
25	9	11.59	0.23753
26	9	11.44	0.24669
27	9	10.62	0.30251

28	9	5.80	0.75991
29	9	6.75	0.66331
30	9	18.49	0.02988
31	9	11.30	0.25563
32	9	10.74	0.29407
33	9	3.74	0.92761
34	9	6.94	0.64340
35	9	8.25	0.50958
36	9	6.67	0.67157
37	9	9.24	0.41575
38	9	10.73	0.29460
39	9	16.33	0.06023
40	9	9.24	0.41578
41	9	2.67	0.97597
42	9	9.81	0.36634
43	9	7.15	0.62162
44	9	11.17	0.26422
45	9	5.60	0.77930
46	9	13.32	0.14862
47	9	4.04	0.90869
48	9	9.05	0.43307
49	9	5.22	0.81465
50	9	11.74	0.22863
51	9	10.31	0.32587
52	9	21.70	0.00987
53	9	9.55	0.38818
54	9	7.77	0.55794
55	9	9.31	0.40960
56	9	5.67	0.77247
57	9	12.75	0.17403
58	9	16.38	0.05935
59	9	7.84	0.55062
60	9	10.87	0.28478
61	9	8.50	0.48457
62	9	12.84	0.16991
63	9	6.76	0.66235
64	9	11.79	0.22548
65	9	7.24	0.61237
66	9	9.70	0.37490
67	9	7.80	0.55419
68	9	6.51	0.68794
69	9	6.72	0.66658
70	9	13.62	0.13656
71	9	24.37	0.00375
72	9	4.54	0.87236
73	9	7.56	0.57936
74	9	12.66	0.17868
75	9	9.41	0.40014
76	9	3.77	0.92592
77	9	13.68	0.13426
78	9	5.57	0.78190
79	9	9.13	0.42544
80	9	6.43	0.69634
81	9	16.80	0.05200
82	9	10.19	0.33494
83	9	9.28	0.41220

84	9	3.99	0.91179
85	9	9.22	0.41713
86	9	8.59	0.47550
87	9	7.44	0.59112
88	9	9.21	0.41817
89	9	12.56	0.18333
90	9	8.36	0.49872
91	9	10.92	0.28141
92	9	8.53	0.48161
93	9	10.71	0.29620
94	9	12.07	0.20956
95	9	6.54	0.68484
96	9	10.24	0.33121
97	9	8.90	0.44671
98	9	4.65	0.86337
99	9	4.89	0.84372
100	9	4.85	0.84693
Combined P-value for all tests (Using KS method)			0.32881

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

### 1.2 Poker hand types statistics for 36 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	8	2.38	0.96716
2	8	11.20	0.19052
Combined P-value for all tests (Using KS method)			N/A (Insufficient data)

Notes:

- 1) Since the number of samples available was insufficient to ensure at least 5 samples in the lowest probability hand type, (Royal Flush), the chi-square test has been performed by merging the Royal Flush and Straight Flush categories.
- 2) As the total number of tests (2) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 3) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 8 months - i.e July 2023 to March 2024.

## 2. Poker rank statistics

The Poker rank analysis aims to establish that the rank of the cards in each position was equally distributed in one of the 13 possible ranks (2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A) for a 52 card deck and 9 ranks (6, 7, 8, 9, 10, J, Q, K, A) for a 36 card deck.

The Poker rank analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Ranks statistics tests.

### 2.1 Poker rank statistics for 52 cards deck:

Test No.	DOF	ChiSqr	P-Value
1	84	84.51	0.46382
2	84	90.09	0.30498
3	84	63.21	0.95609
4	84	113.25	0.01840
5	84	77.73	0.67153
6	84	82.07	0.53933

7	84	77.83	0.66882
8	84	97.95	0.14174
9	84	65.48	0.93285
10	84	84.83	0.45418
11	84	80.84	0.57741
12	84	77.31	0.68396
13	84	79.54	0.61747
14	84	80.46	0.58926
15	84	96.68	0.16252
16	84	83.85	0.48417
17	84	89.69	0.31531
18	84	85.30	0.43997
19	84	116.69	0.01063
20	84	77.48	0.67910
21	84	76.05	0.71978
22	84	78.80	0.63994
23	84	97.67	0.14622
24	84	85.48	0.43450
25	84	91.32	0.27416
26	84	97.20	0.15383
27	84	73.71	0.78148
28	84	84.92	0.45148
29	84	75.66	0.73046
30	84	101.95	0.08893
31	84	75.70	0.72935
32	84	99.92	0.11328
33	84	78.16	0.65886
34	84	106.46	0.04954
35	84	109.19	0.03380
36	84	87.48	0.37586
37	84	87.28	0.38164
38	84	78.69	0.64303
39	84	85.88	0.42258
40	84	57.57	0.98781
41	84	98.59	0.13199
42	84	92.40	0.24877
43	84	80.22	0.59665
44	84	102.88	0.07921
45	84	88.64	0.34365
46	84	73.80	0.77905
47	84	74.48	0.76172
48	84	88.98	0.33441
49	84	96.45	0.16665
50	84	95.11	0.19139
51	84	68.77	0.88544
52	84	91.89	0.26063
53	84	95.23	0.18897
54	84	93.25	0.22963
55	84	89.44	0.32210
56	84	83.75	0.48707
57	84	94.68	0.19981
58	84	84.16	0.47467
59	84	73.19	0.79402
60	84	79.05	0.63240
61	84	100.88	0.10125
62	84	53.06	0.99666

63	84	86.16	0.41412
64	84	79.61	0.61535
65	84	87.21	0.38352
66	84	80.85	0.57709
67	84	82.32	0.53156
68	84	68.39	0.89175
69	84	73.57	0.78479
70	84	77.62	0.67475
71	84	81.71	0.55044
72	84	82.27	0.53288
73	84	94.92	0.19495
74	84	74.44	0.76292
75	84	103.58	0.07245
76	84	91.20	0.27704
77	84	80.16	0.59848
78	84	84.62	0.46043
79	84	88.40	0.35010
80	84	106.75	0.04762
81	84	93.33	0.22780
82	84	79.28	0.62547
83	84	97.31	0.15192
84	84	78.20	0.65767
85	84	77.11	0.68966
86	84	81.23	0.56544
87	84	87.86	0.36515
88	84	89.74	0.31411
89	84	75.92	0.72327
90	84	67.16	0.91079
91	84	64.16	0.94725
92	84	108.57	0.03694
93	84	50.85	0.99840
94	84	58.78	0.98347
95	84	94.47	0.20392
96	84	67.24	0.90963
97	84	71.29	0.83710
98	84	93.91	0.21554
99	84	76.91	0.69543
100	84	79.63	0.61456
Combined P-value for all tests (Using KS method)			0.53472

*Notes:*

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

## 2.2 Poker rank statistics for 36 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	56	52.81	0.59623
2	7	56	65.86	0.17245
3	7	56	43.31	0.89244
4	7	56	46.37	0.81702
5	7	56	59.29	0.35640
6	7	56	71.50	0.07936
7	7	56	48.71	0.74456
8	7	56	53.31	0.57729
Combined P-value for all tests (Using KS method)				N/A (Insufficient data)

### Notes:

- 1) As the total number of tests (8) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 8 months - i.e July 2023 to March 2024.

## 3. Poker suits statistics

The Poker suits analysis aims to verify that the cards dealt exhibit an equal probability of all 4 suits (Clubs, Diamonds, Hearts and Spades) in all positions.

The Poker suits analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Suits statistics tests.

### 3.1 Poker suits statistics for 52 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	21	27.18	0.16486
2	7	21	41.56	0.00478
3	7	21	31.33	0.06827
4	7	21	26.83	0.17639
5	7	21	17.84	0.65907
6	7	21	20.42	0.49507
7	7	21	17.08	0.70601
8	7	21	15.52	0.79579
9	7	21	16.46	0.74334
10	7	21	14.46	0.84917
11	7	21	13.19	0.90165
12	7	21	27.35	0.15947
13	7	21	20.09	0.51551
14	7	21	24.39	0.27450
15	7	21	14.39	0.85210
16	7	21	18.61	0.61018
17	7	21	18.08	0.64396
18	7	21	19.22	0.57082
19	7	21	8.38	0.99332
20	7	21	27.63	0.15085
21	7	21	22.18	0.38914
22	7	21	33.43	0.04165
23	7	21	16.70	0.72928

24	7	21	22.05	0.39654
25	7	21	23.82	0.30186
26	7	21	12.99	0.90910
27	7	21	28.04	0.13896
28	7	21	29.31	0.10680
29	7	21	24.84	0.25423
30	7	21	27.39	0.15833
31	7	21	30.12	0.08952
32	7	21	35.15	0.02719
33	7	21	16.19	0.75894
34	7	21	17.21	0.69817
35	7	21	14.81	0.83241
36	7	21	20.54	0.48756
37	7	21	17.30	0.69268
38	7	21	13.47	0.89144
39	7	21	30.77	0.07765
40	7	21	19.58	0.54783
41	7	21	22.01	0.39878
42	7	21	19.97	0.52340
43	7	21	20.90	0.46531
44	7	21	23.50	0.31781
45	7	21	28.12	0.13673
46	7	21	21.72	0.41559
47	7	21	9.51	0.98456
48	7	21	18.35	0.62654
49	7	21	21.57	0.42447
50	7	21	18.00	0.64928
51	7	21	16.21	0.75791
52	7	21	30.16	0.08876
53	7	21	27.38	0.15850
54	7	21	14.95	0.82564
55	7	21	16.44	0.74427
56	7	21	18.78	0.59953
57	7	21	38.77	0.01047
58	7	21	21.89	0.40612
59	7	21	19.25	0.56910
60	7	21	14.22	0.85992
61	7	21	23.21	0.33284
62	7	21	25.67	0.21928
63	7	21	22.02	0.39811
64	7	21	13.43	0.89283
65	7	21	34.86	0.02928
66	7	21	12.97	0.90981
67	7	21	9.84	0.98092
68	7	21	14.37	0.85340
69	7	21	24.81	0.25560
70	7	21	19.84	0.53135
71	7	21	24.76	0.25779
72	7	21	31.47	0.06613
73	7	21	20.39	0.49700
74	7	21	9.05	0.98878
75	7	21	16.82	0.72213
76	7	21	31.35	0.06800
77	7	21	16.37	0.74869
78	7	21	23.29	0.32897
79	7	21	29.31	0.10674

80	7	21	14.95	0.82565
81	7	21	17.96	0.65159
82	7	21	30.49	0.08257
83	7	21	27.24	0.16294
84	7	21	17.92	0.65400
85	7	21	18.84	0.59543
86	7	21	12.13	0.93596
87	7	21	19.79	0.53463
88	7	21	15.51	0.79653
89	7	21	18.83	0.59573
90	7	21	41.20	0.00530
91	7	21	25.00	0.24729
92	7	21	16.65	0.73222
93	7	21	23.03	0.34230
94	7	21	12.21	0.93380
95	7	21	21.60	0.42283
96	7	21	21.64	0.42056
97	7	21	16.05	0.76660
98	7	21	17.09	0.70556
99	7	21	28.17	0.13541
100	7	21	31.01	0.07356
Combined P-value for all tests (Using KS method)				0.60828

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there are sufficient data.

### 3.2 Poker suits statistics for 36 cards deck:

Test No.	Positions	DOF	ChiSqr	P-Value
1	7	21	14.21	0.86050
2	7	21	27.94	0.14175
3	7	21	23.97	0.29461
4	7	21	11.35	0.95549
5	7	21	25.78	0.21512
6	7	21	17.27	0.69449
7	7	21	12.58	0.92250
8	7	21	29.79	0.09629
Combined P-value for all tests (Using KS method)				N/A (Insufficient data)

Notes:

- 1) As the total number of tests (8) is insufficient to perform a meaningful KS Test, individual p-values from these tests are carried over to the next stage for combining using the Holm's method.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 8 months - i.e July 2023 to March 2024.

## 4. Summary of the analysis

### 4.1 Summary of the analysis of 52 cards deck:

The analysis of 52 cards completes by combining the result of the KS Test performed in the 3 types of analysis (Hand Types, Ranks and Suits) for 52 card decks using the Holm's method and producing a single Combined P -value.

The combined p-value produced using the Holm's method is used as indication for statistical randomness.



<b>Combination of p-values using Holm's Method</b>		
<b>Test</b>	<b>P-Value</b>	<b>P-Adjusted</b>
Ranks Test	0.53472	1.00000
Suits Test	0.60828	1.00000
Hand Types Test	0.32881	0.98644
<b>Combined P-Value using Holm's Method</b>		0.98644

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for 52 card decks is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.

The final outcome of the analysis of 52 cards deck indicates that the RNG is working correctly.

#### 4.2 Summary of the analysis of 36 cards deck:

The analysis of 36 cards completes by combining the result of the KS Test performed in the 3 types of analysis (Hand Types, Ranks and Suits) for 36 card decks using the Holm's method and producing a single Combined P -value. Where there is insufficient data the individual Chi-Square tests results are used in the Holm's method for producing a combined p-value.

The combined p-value produced from the using the Holm's method is used as indication for statistical randomness.

<b>Combination of p-values using Holm's Method</b>		
<b>Test</b>	<b>P-Value</b>	<b>P-Adjusted</b>
Ranks Test 1	0.59623	1.00000
Ranks Test 2	0.17245	1.00000
Ranks Test 3	0.89244	1.00000
Ranks Test 4	0.81702	1.00000
Ranks Test 5	0.35640	1.00000
Ranks Test 6	0.07936	1.00000
Ranks Test 7	0.74456	1.00000
Ranks Test 8	0.57729	1.00000
Suits Test 1	0.86050	1.00000
Suits Test 2	0.14175	1.00000
Suits Test 3	0.29461	1.00000
Suits Test 4	0.95549	1.00000
Suits Test 5	0.21512	1.00000
Suits Test 6	0.69449	1.00000
Suits Test 7	0.92250	1.00000
Suits Test 8	0.09629	1.00000
Hand Types Test 1	0.96716	1.00000
Hand Types Test 2	0.19052	1.00000
<b>Combined P-Value using Holm's Method</b>		1.00000

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for 36 card decks is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.
- 2) Since the number of games played each month using 36 card decks is small, the number of samples available this month as well as a few previous months were insufficient to perform a meaningful statistical analysis. Hence the analysis performed this month was done using the cumulative data for the last 8 months - i.e July 2023 to March 2024.

The final outcome of the analysis of 36 cards deck indicates that the RNG is working correctly.

## 5. Conclusion

Analysis of actual data from game logs for 'Hand Types', 'Ranks' and 'Suits' for **52-card decks** and **36-card decks** indicated statistical randomness.

iTech Labs has done limited sanity checks to verify the integrity of the game logs. iTech Labs also maintains a copy of the game logs for verification purposes. There were a large enough number of game records to give the calculations sufficient statistical power.

We conclude that the Random Number Generator (RNG) is working correctly.

Please click here to see the [Original](#) report.

---

**Signed:**



---

**Alvin Rizaldi**  
**Chief Executive Officer**  
**iTech Labs**  
Date: 22 April 2024

---

**Signed:**



---

**Divya Bhargava**  
**Project Manager**  
**iTech Labs**  
Date: 22 April 2024

---

Disclaimer.

While it is not possible to test all possible scenarios in a laboratory environment, iTech Labs has conducted a level of testing appropriate for a component test of this type.

