

# NEC - Vendor Performance Assessment – 1.0

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## **1 Introduction**

This report details the biometric performance review and comparison of the NEC facial recognition (FR) algorithms which were tested for the Department Internal Affairs New Zealand (DIA). Biometric accuracy was tested against a sample of Passport image data and a selection of the results of this analysis are presented in this report.

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## 2 FR Performance A: General Accuracy

This section presents the results of the identification testing on biometric performance. The analysis was undertaken on gallery containing approximately 400,000 individuals with varying quality across image generations and including a selection of images of individuals less than 16 years of age.

The general accuracy test results are presented for both Identification and Verification in the following sections.

### 2.1 Current Generation Images

The I-1 gallery set contains a total of 358,677 images. These images are primarily from the current generation of passport images (G4) at 600dpi. There are additional subtests with previous generations at 300dpi (I2) which were included in the results; however, they are not included in the analysis below for I-1.

The table below shows the rank data for the large gallery of current generation images test set, indicating the likelihood of correctly identifying an individual at the given ranking.

Rank	NEC
1	99.64
5	99.86
10	99.90
50	99.97

### 2.2 Previous Generation Test

Tests were conducted to compare the performance of biometric matching when matching current generation 600 dpi images with previous generation passport images for the gallery I-2 compared to 600dpi I-1A.

For reference, the probe details are below.

- I-1A – Mated G4 to G4
- I-2A – Mated G4 to G3
- I-2B – Mated G3 to G3
- I-2C – Mated G4 to G2
- I-2D – Mated G4 to G1

The results for NEC on the previous generation images test are shown in the CMC curve for I-2 in Figure 1

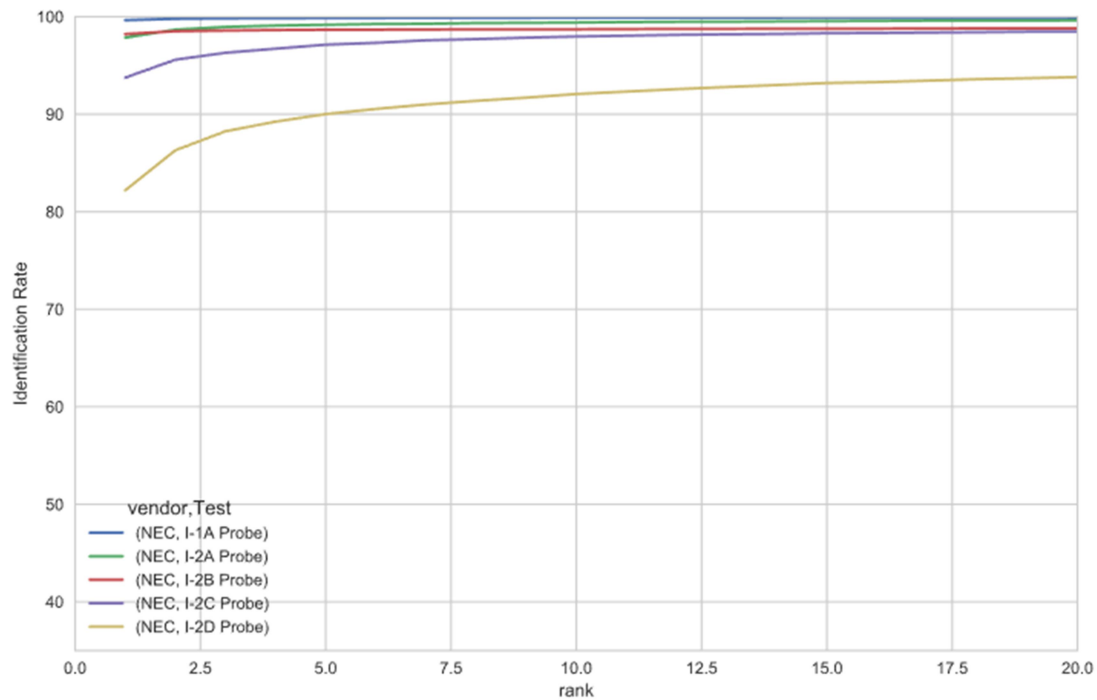


Figure 1: Comparison CMC curve for NEC for Previous Generation Test

The identification rates per rank are shown in the table below for each subtest.

Rank	NEC				
	1-1A	1-2A	1-2B	1-2C	1-2D
1	99.64	97.85	98.22	93.75	82.19
5	99.86	99.17	98.66	97.13	90.01
10	99.90	99.40	98.71	97.97	92.07
50	99.97	99.81	98.86	98.88	95.63

1-1A Column shows comparison against results for G4 against G4 (best quality).

### 2.3 Verification Accuracy

The overall verification results for the verification data set for NEC are shown in Figure 2.

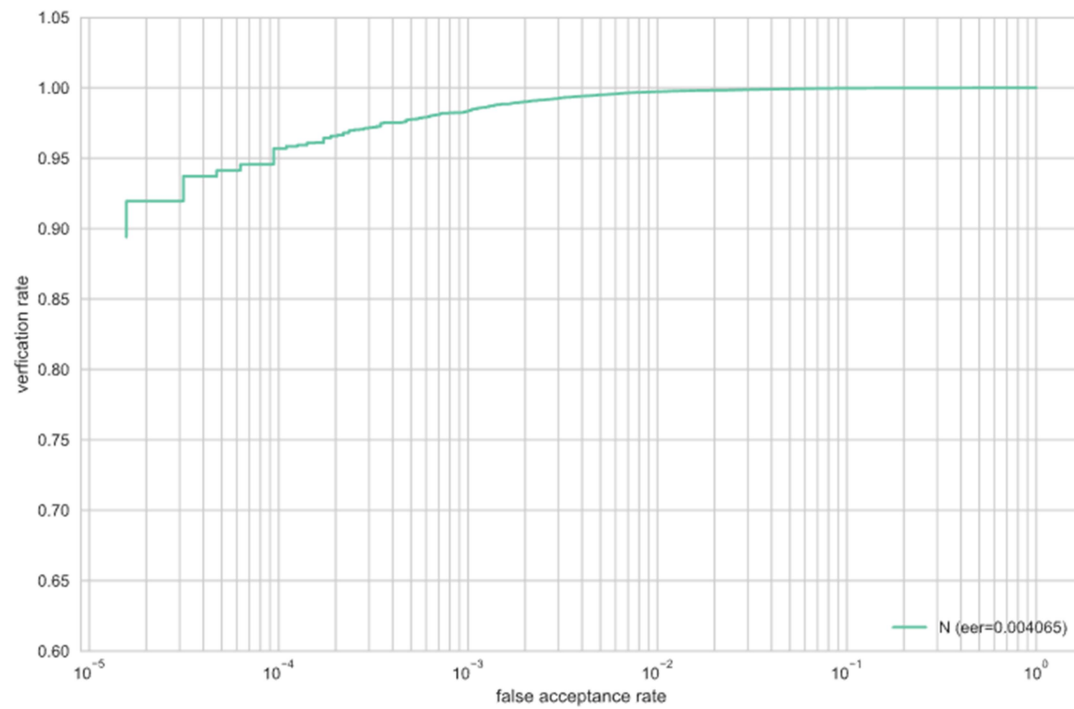


Figure 2: NEC ROC curve for verification

The table below indicates false reject rates (FRR) at a threshold for verification tests.

FAR	Verification Rate	Threshold
0.1	98.35	0.4162
0.5	99.50	0.3207
1.0	99.73	0.2512

## 3 FR Performance II: Problem demographics and age effects

### 3.1 Demographics

Tests were conducted to assess the performance with consideration to gender and age effects. These were assessed with the I-1 Test set and I-6 Youth set.

#### 3.1.1 Gender

The following section shows the NEC performance on gender.. The CMC results are shown in Figure 3.

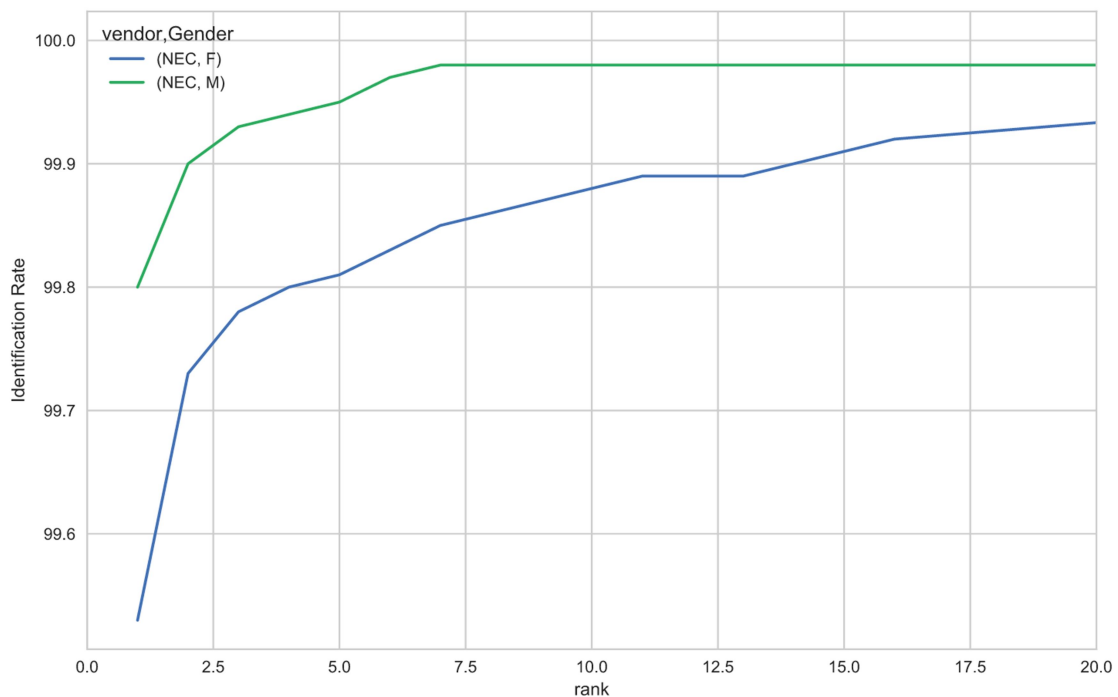


Figure 3: Comparison CMC curve for Gender I1 (NEC)

The table below shows the identification rates for each gender at a given ranking.

Rank	NEC	
	F	M
1	99.53	99.80
5	99.81	99.95
10	99.88	99.98
50	99.99	99.99



### 3.2 Ageing and Youth

Figure 4 shows the CMC curve for the following specific age-related test-cases for NEC where 11-15 year olds of differing image generation are mated to G4 images of adult of varying ages:

- I-6A – G4, Mated 16-23 years
- I-6C – G4, Mated 16-31 years
- I-6D – G4, Mated 19-35 years
- I-6E – G4, Mated 24-40 years

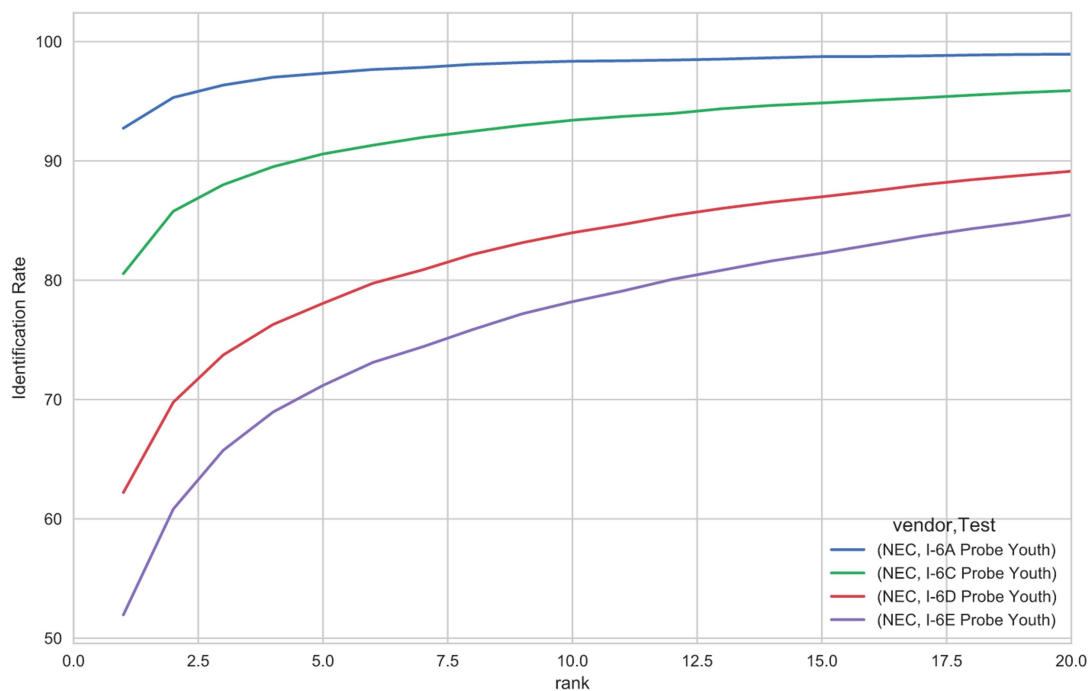


Figure 4: NEC CMC curve for Age Mated Pairs

The table below shows the identification rates for each age probe for NEC at a given ranking for the probe match with the CMC above.

Rank	I-6A Probe Youth	I-6C Probe Youth	I-6D Probe Youth	I-6E Probe Youth
1	92.74	80.55	62.21	51.96
5	97.34	90.58	78.06	71.18
10	98.35	93.41	83.98	78.20
50	99.69	98.34	95.53	94.25

### 3.3 Adult Aging

The following sections for NEC highlight the age at photos with less than 5, between 5 and 9, between 10 and 14 and greater than 15 year gap for the same individual. The test data in this analysis considers only adult data sets.

#### 3.3.1 Age gap of 5 years or less

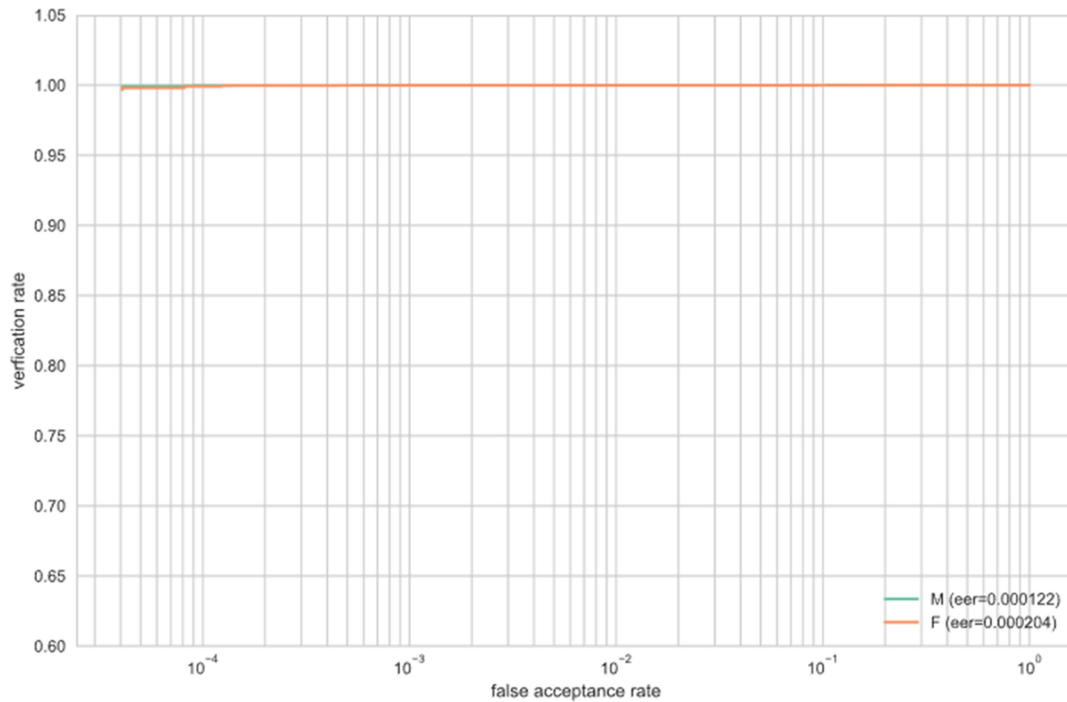


Figure 5: NEC ROC Results for age gap of 5 years or less

The ROC Results for age gap of 5 years or less are shown in the table below with the accompanying ROC plot above (Figure 5).

Gender	M	F
FAR	Rate	Rate
0.1	99.98	99.99
0.5	99.99	99.99
1.0	99.99	99.99

### 3.3.2 Age gap between 5 and 9 years

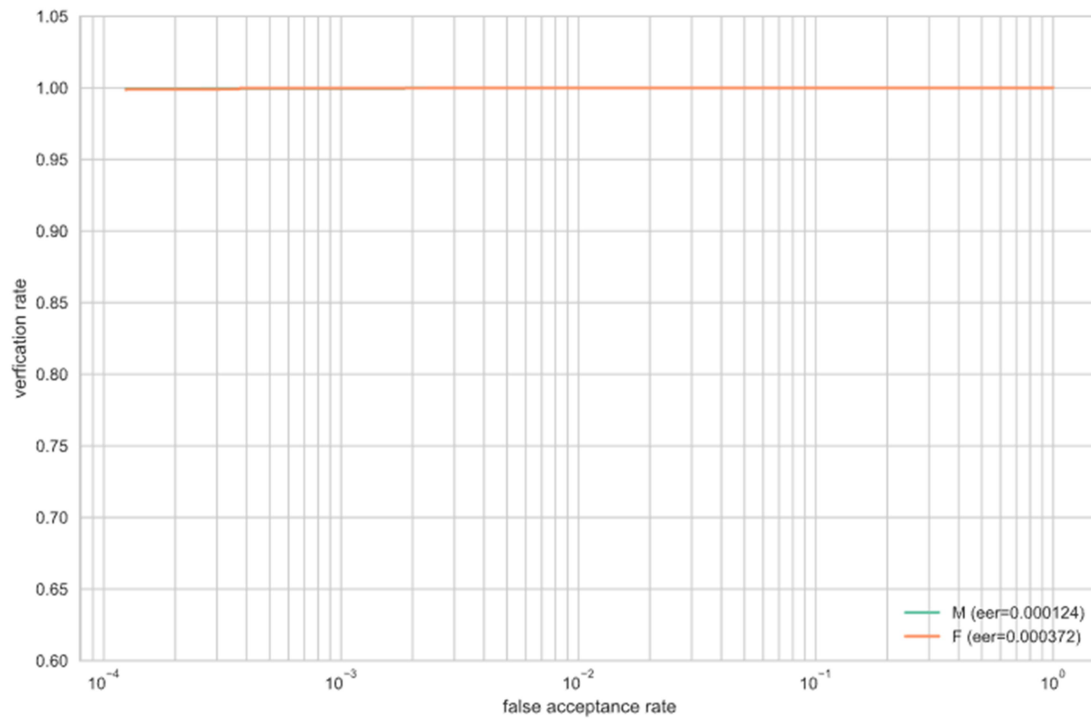


Figure 6: NEC ROC results for age gap between 5 and 9 years

The ROC Results for age gap between 5 and 9 years are shown in the table below with the accompanying ROC plot above (Figure 6).

Gender	M	F
FAR	Rate	Rate
0.1	99.96	99.98
0.5	100.00	99.99
1.0	100.00	99.99

### 3.3.3 Age gap between 10 and 14 years

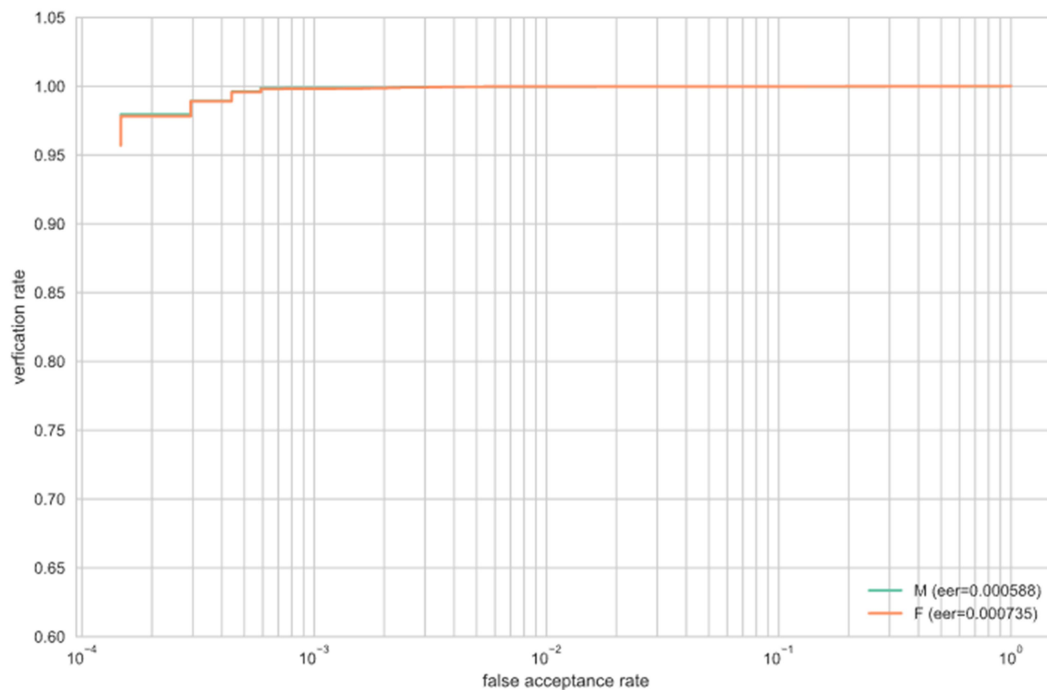


Figure 7: NEC ROC results for age gap between 10 and 14 years

The ROC Results for age gap between 10 and 14 years are shown in the table below with the accompanying ROC plot above (Figure 7).

Gender	F	M
FAR	Rate	Rate
0.1	99.87	99.82
0.5	99.96	99.96
1.0	99.97	99.98

### 3.3.4 Age gap of 15 years or greater

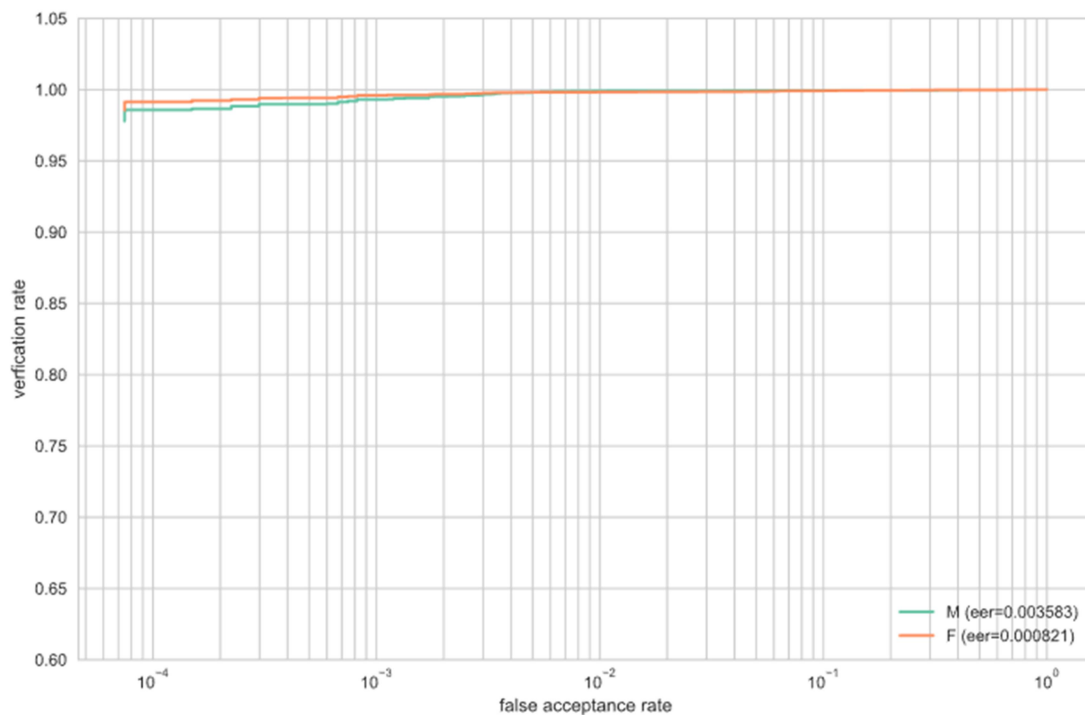


Figure 8: NEC ROC results for age gap of 15 years or greater

The ROC Results for age gap of 5 years or less are shown in the table below with the accompanying ROC plot above (Figure 8).

Gender	F	M
FAR	Rate	Rate
0.1	99.60	99.31
0.5	99.81	99.82
1.0	99.83	99.89

### 3.4 Youth Aging

The following sections for NEC highlight the age at photo with less than 5, between 5 and 9, between 10 and 14 and greater than 15 year gap from a gallery of youth.

### 3.4.1 Age gap of 5 years or less

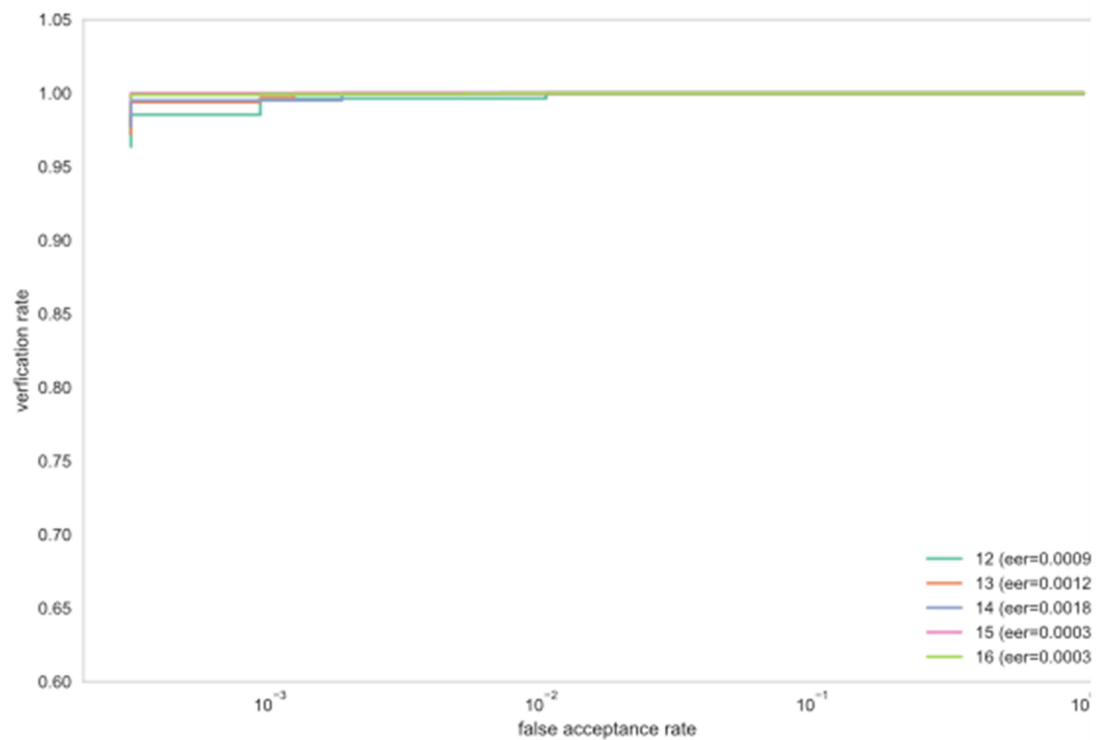


Figure 9: NEC ROC Results with age gap of 5 years or less

The ROC Results for age gap of 5 years or less are shown in the table below with the accompanying ROC plot above (Figure 9).

AgeAtPhoto	12	13	14	15	16
FAR	Rate	Rate	Rate	Rate	Rate
0.1	99.63	99.69	99.50	100.0	99.92
0.5	99.63	100.0	100.0	100.0	99.92
1.0	99.63	100.0	100.0	100.0	100.0

### 3.4.2 Age gap between 5 and 9 years

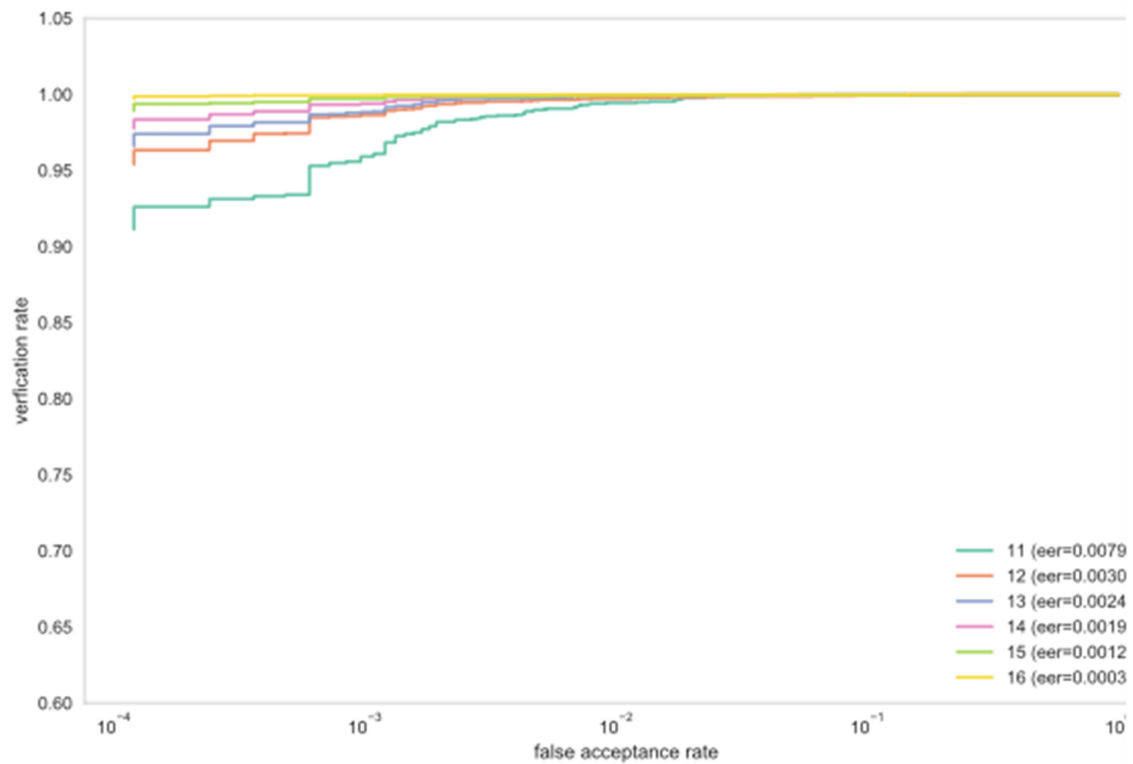


Figure 10: NEC ROC Results with age gap between 5 and 9 years

The ROC Results for age gap between 5 and 9 years is shown in the table below with the accompanying ROC plot above (Figure 10).

AgeAtPhoto	11	12	13	14	15	16
FAR	Rate	Rate	Rate	Rate	Rate	Rate
0.1	95.91	98.64	98.84	99.38	99.71	99.93
0.5	98.98	99.64	99.78	99.92	99.87	99.97
1.0	99.44	99.72	99.92	99.97	99.90	99.97

### 3.4.3 Age gap between 10 and 14 years

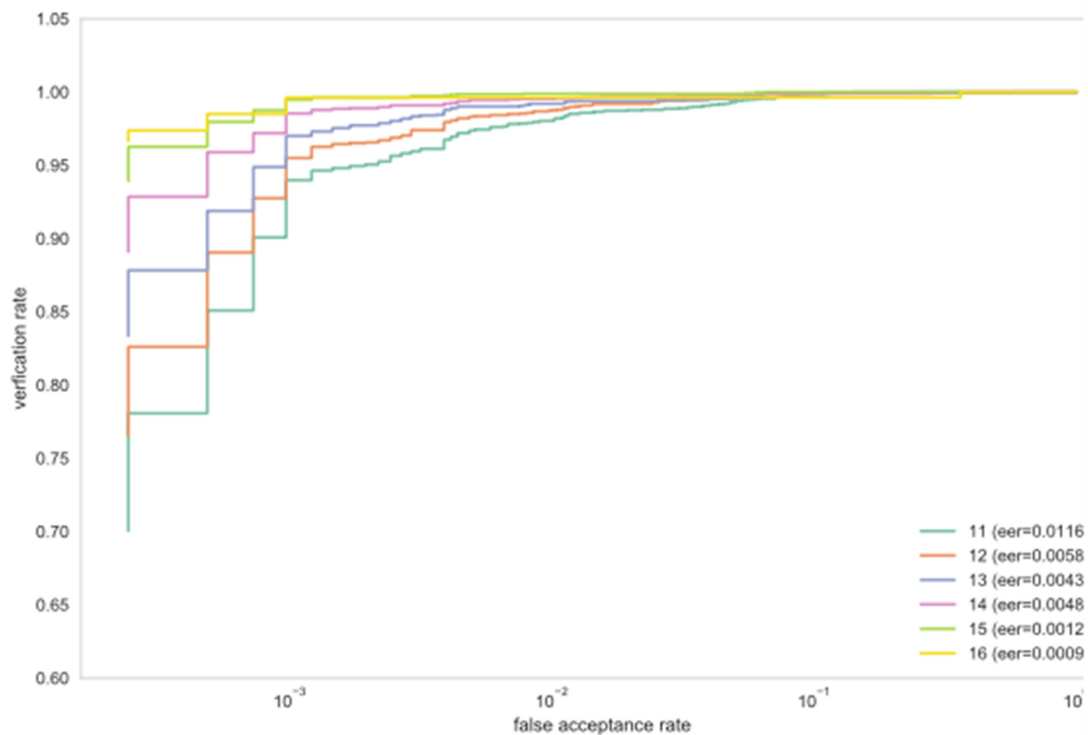


Figure 11: NEC ROC Results with age gap between 10 and 14 years

The ROC Results for age gap between 10 and 14 years is shown in the table below with the accompanying ROC plot above (Figure 11).

AgeAtPhoto	11	12	13	14	15	16
FAR	Rate	Rate	Rate	Rate	Rate	Rate
0.1	93.98	95.50	97.00	98.54	99.47	99.63
0.5	97.37	98.32	99.01	99.45	99.85	99.63
1.0	98.03	98.76	99.20	99.53	99.89	99.63



### 3.4.4 Age gap of 15 years or greater

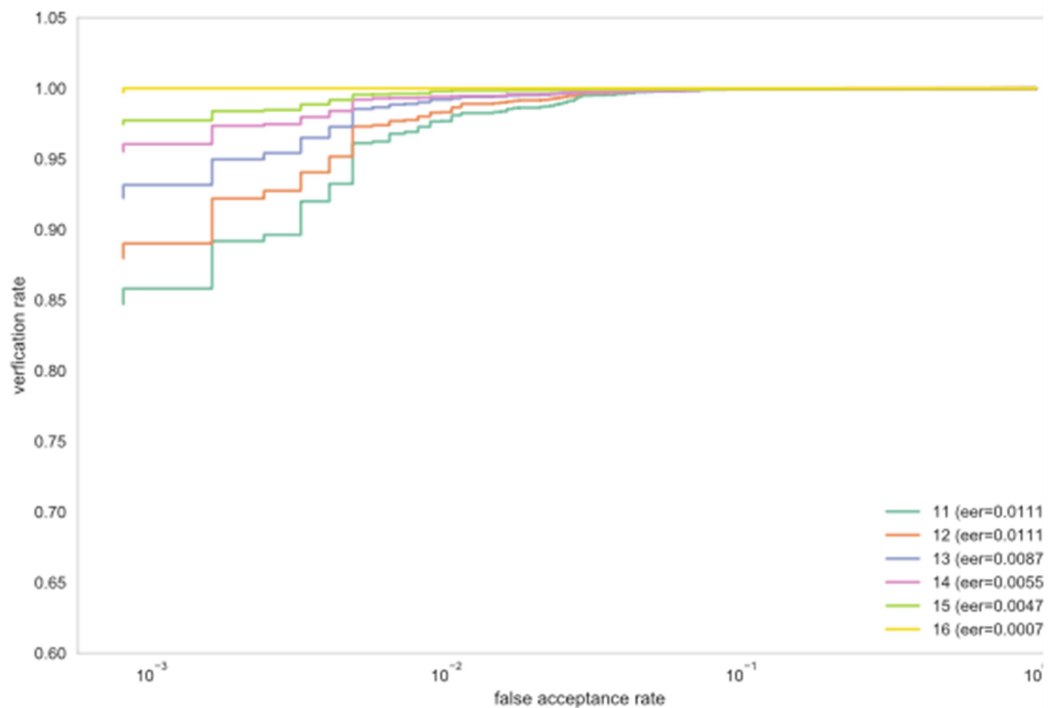


Figure 12: NEC ROC Results with age gap of 15 years or greater

The ROC Results for age gap of 15 years or greater is shown in the table below with the accompanying ROC plot above (Figure 12).

AgeAtPhoto	11	12	13	14	15	16
FAR	Rate	Rate	Rate	Rate	Rate	Rate
0.1	85.81	89.01	93.16	96.05	97.73	100.00
0.5	96.12	97.30	98.54	99.20	99.55	100.00
1.0	97.67	98.31	99.20	99.41	99.80	100.00