
Procedure for DNA Quantitation with Quantifiler® Duo

1.0 Purpose – This procedure specifies the steps for performing quantification of DNA extracts with the Quantifiler® Duo kit on the ABI 7500 instruments.

2.0 Scope – This procedure applies to casework analysts and trainees in the Forensic Biology Section who are qualified to use the ABI 7500 instruments.

3.0 Definitions

- **C_T** -- The cycle number when fluorescence in the assay crosses the threshold of detection and the PCR reaction is in the exponential phase; lower C_T values indicate samples with higher concentrations, and higher C_T values indicate samples with lower concentrations.
- **Inhibition** – The total or partial suppression of the PCR process that would result in a partial or no DNA profile being obtained.
- **Internal Positive Control (IPC)** – A synthetic sequence of DNA not found in nature that is present in all Quantifiler Duo reactions. It is used as a means to distinguish between true negative sample results and reactions affected by the presence of PCR inhibitors, assay setup, or chemistry/instrument failure.
- **Non Template Control (NTC)** – A negative control used in the quantitation assay; STR-TE is used.
- **R² value** – This value measures the closeness of fit between the standard curve and the C_T values of the DNA standard used in the assay. A value of 1.00 indicates a perfect fit between the DNA data points and the curve.
- **Slope** – This value indicates the efficiency of the PCR reaction in the assay. A value of -3.3 indicates 100 % efficiency.
- **Y-intercept** – The C_t value of a theoretical 1 ng/μl sample; a shift of 1 C_T can result in either a half or a doubling of the estimation of a sample's quantity.

4.0 Equipment, Materials and Reagents

- Quantifiler® Duo Kit and associated reagents
- ABI 7500 Real-Time PCR Instrument (ABI 7500) and associated computer
- HID Real-Time Analysis Software v 1.1
- Microsoft Excel, NotePad
- 96-well optical plates and optical adhesive covers
- Calibrated pipets and tips
- Centrifuge
- Vortex mixer
- Laminar Flow Clean Air Bench
- STR-TE
- Base plate
- Extracted DNA
- Various laboratory equipment (microcentrifuge tubes, wipes, etc.)

5.0 Procedure

5.1 Introduction

- 5.1.1** The ABI 7500 Real-Time PCR System uses fluorescence-based polymerase chain reaction reagents to provide quantitative detection of nucleic acid (DNA) targets using real-time analysis.
- 5.1.2** The Quantifiler® Duo kit is designed to simultaneously quantify the total amount of amplifiable human DNA and human male DNA in a sample.
- 5.1.3** Interpretation of the results is dependent upon the quality metrics of the standard curves (R^2 value, y-intercept and slope), and the performance of the IPC.

5.2 Preparation of the Standard Curve

- 5.2.1** The Quantifiler® Duo Standard Curve (Standards) shall be prepared as described in the Forensic Biology Procedure for DNA Reagent Preparation and Quality Control.
- 5.2.2** The Standards shall be vortexed for three to five seconds and centrifuged briefly prior to each use by Forensic Scientists.

5.3 Preparation of the Plate Document

- 5.3.1** Forensic Scientists shall use the Microsoft Excel “Quantifiler Duo Setup Worksheet” (Setup Worksheet) to calculate the amount of reagents necessary for the number of samples to be analyzed per plate. This Setup Worksheet takes the standard curve into account for the calculations. Note: No more than 30 total items (including controls) per analyst may be processed simultaneously.
- 5.3.2** Each plate shall have one Non Template Control (NTC) included.
- 5.3.3** The Setup Worksheet shall be saved to the Quant Setup folder on the computer associated with the 7500 the Forensic Scientist will use to perform the assay (D:\AppliedBiosystems\Quant Setup\).

5.4 Preparation of the Reaction

- 5.4.1** Vortex the Quantifiler® Duo Primer Mix for three to five seconds and then centrifuge briefly before opening the tube. Add the volume as provided in the Setup Worksheet to an autoclaved microcentrifuge tube.
- 5.4.2** Gently swirl the Quantifiler® Duo Reaction Mix and mix by pipetting up and down several times. Do not vortex the Reaction Mix. Add the volume as provided in the Setup

Worksheet to the microcentrifuge tube already containing the Primer Mix. This combination of Primer and Reaction Mix is now the Master Mix.

- 5.4.3 Assemble a 96-well optical plate into a black base. Do not place the optical plate directly onto the benchtop in order to protect it from scratches and other particulate matter.
- 5.4.4 Vortex the Master Mix for three to five seconds and then centrifuge briefly. Dispense 23 µl of Master Mix into each well of the optical plate, per the Setup Worksheet.
- 5.4.5 Add 2 µl of STR-TE to the well designated for the NTC.
- 5.4.6 Add 2 µl of each sample to the wells as designated by the Setup Worksheet.
- 5.4.7 Add 2 µl of each Standard (in duplicate) to the wells as designated by the Setup Worksheet.
- 5.4.8 Seal the plate with an optical adhesive cover. Centrifuge the plate at 3000 rpm for 20 seconds. Centrifuge again if bubbles remain at the bottom of the wells.

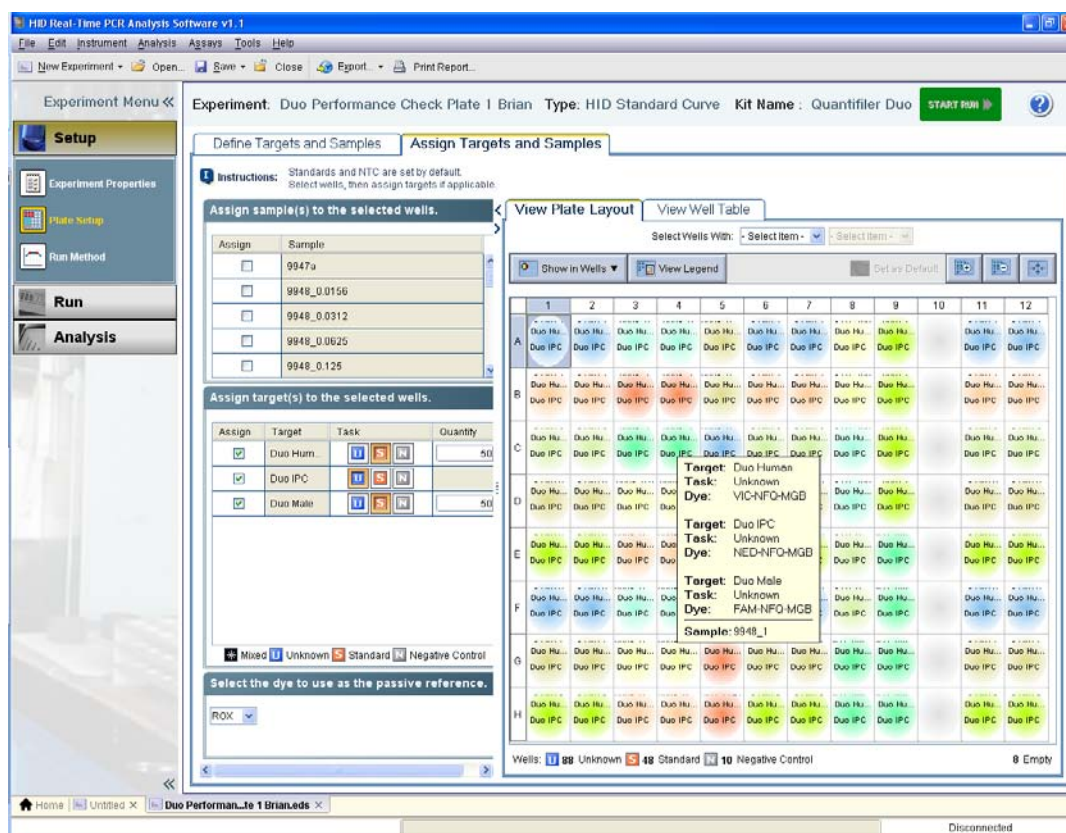
5.5 Operation of the ABI 7500

- 5.5.1 Turn on the 7500 instrument. Forensic Scientists shall open the HID Real-Time PCR Analysis Software v. 1.1 and log in under their user name. Use and analysis of data under the generic guest log in is not permitted for casework.
- 5.5.2 Push the instrument door in and then release it to open. The plate holder will eject from the instrument. Place the optical plate into the holder with the notch in the top right corner. Well A1 will be in the top left corner. A compression pad is not necessary on the 7500 instrument.
- 5.5.3 Locate the Setup Worksheet saved on the computer as described in 5.3.4 and open it in Excel. **Note:** Excel must be version 2000 or earlier when converting to a .txt file otherwise the Import function in 5.5.5 cannot be performed.
- 5.5.4 Select the ABI 7500 Sample Setup Quant Duo tab at the bottom of the Setup Worksheet. Copy and paste the entire contents of the worksheet (use Control + A) into a Notepad document. Save this .txt file in the same location as the Setup Worksheet. Close both the Excel and Notepad programs.
- 5.5.5 Within the HID software, select the Quantifiler Duo option (top left). From the File option in the menu, select Import. Find and select the .txt file created and saved in 5.5.4. Select Start Import. A “Confirm Import Plate Setup” message will appear, asking “Are you sure you want to continue with the import?” Select Yes.

- 5.5.6** In the Experiment Menu on the left side, under Setup, select Experiment Properties. Enter the file name in Experiment Name in the following format: MMDDYYYY_ABC (full date_Forensic Scientist initials). Verify that the following are selected:

Instrument: 7500 (96 wells)
Experiment Type: Quantitation – HID Standard Curve
Reagents: TaqMan® Reagents
Ramp Speed: Standard (~2 hours to complete a run)

- 5.5.7** In the Experiment Menu on the left side, under Setup, select Plate Setup. Select the Assign Targets and Samples tab. Verify that the wells contain the correct samples/sample names. Hover the mouse above the well and the sample name will appear at the bottom of the box:

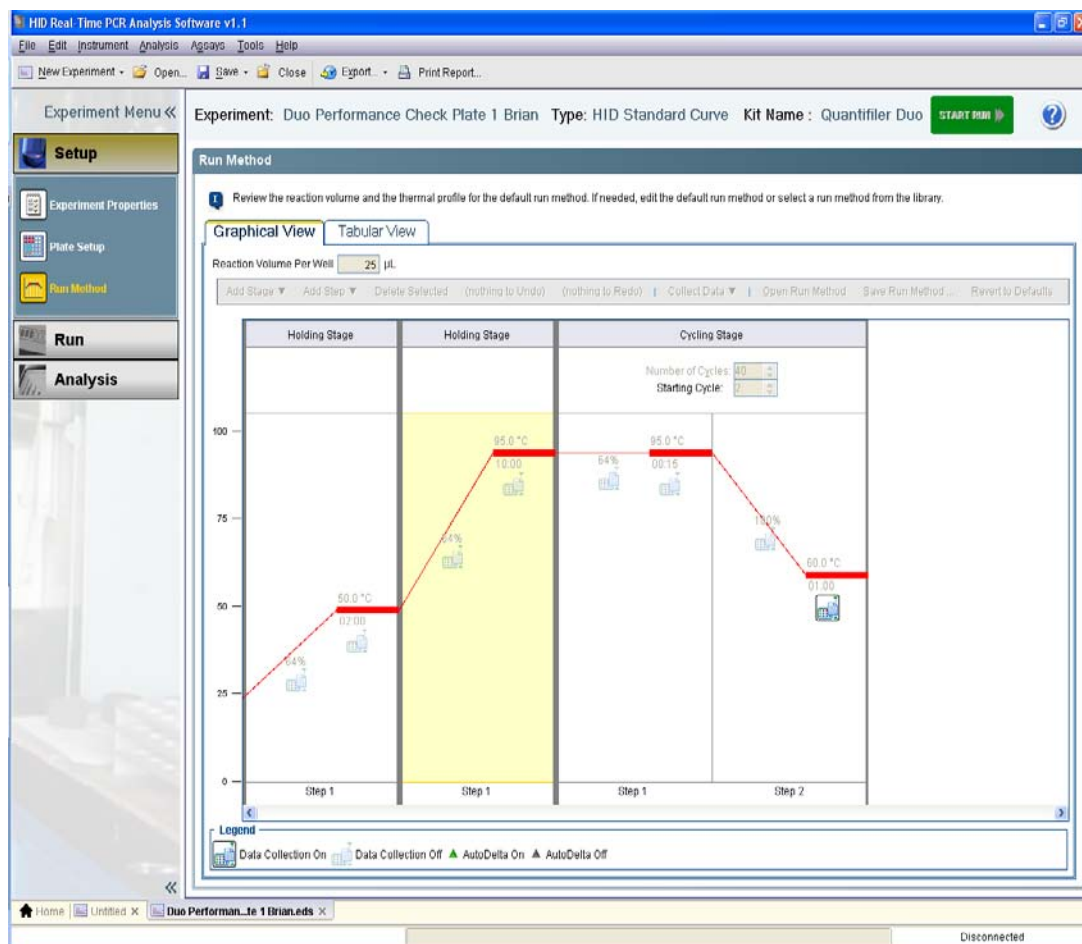


- 5.5.8** If a sample needs to be added to the plate, double-click on the empty well and select Add Sample from the text box that appears and enter the sample name. Close the box by clicking on the X in the top right corner. Note: these steps can also be used to change the name of a sample.

- 5.5.9** If a sample needs to be removed from the plate, right-click the sample and select clear.

- 5.5.10** In the Experiment Menu on the left side, under Setup, select Run Method. Verify that reaction volume per well is 25 µl, the number of cycles is set to 40, and that the starting

cycle is set to 2 (this can be visualized in either the graphical or tabular views). Also verify that the run method steps are as seen below:



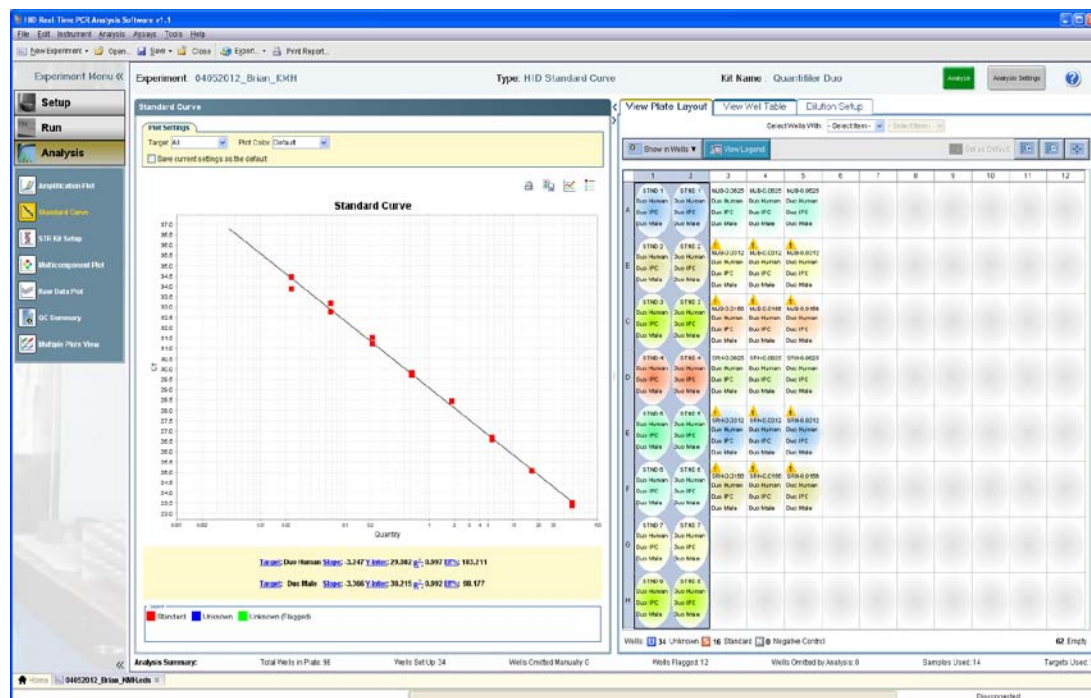
5.5.11 In the top menu bar, select File and Save As. Name the .eds file as described in 5.5.6 (i.e., MMDDYYYY_ABC). This .eds file shall be saved within the Forensic Scientist's folder on the D drive (D:\AppliedBiosystems\EDS Documents\) on the computer associated with the 7500 instrument. Forensic Scientists shall not move or delete the .eds file. The .eds files shall be removed and stored in an alternate secure format approximately every 90 days by the Quality Control Officer or designee (QCO).

5.5.12 Click on the green Start Run button. Do not click on this button more than once. The assay will take approximately an hour and forty-five minutes to complete.

5.6 Analysis of Quantifiler Duo Data

5.6.1 Once the assay has finished, click on the green Analyze button in the top right corner of the screen.

5.6.2 Assessing the Standard Curve: In the Experiment Menu, under Analysis, select Standard Curve. To display only the wells containing the standard curve, highlight them in the table to the right of the curve. The human or male or both standard curves can be visualized by selecting all, Duo Human or Duo Male from the drop-down menu by Target:



5.6.2.1 The slope for both the human and the male standard curves shall be between or equal to -3.00 and -3.60, and the R^2 shall be ≥ 0.98 .

5.6.2.2 Forensic Scientists may drop up to 2 points from each curve in order to achieve the criteria in 5.6.2.1. The same 2 points may be dropped from the same standard, for both the human and the male curves if necessary, but only for Standard H.

5.6.2.2.1 The HID software allows the user to select the human, the male, or both when selecting point(s) to drop. Right-click on the well containing the standard to be dropped from the curve; select omit well and choose both, Duo Human or Duo Male.

5.6.2.2.2 The data must be reanalyzed with the modified standard curve: select Analyze.

5.6.2.2.3 If a point can be added back to the standard curve, right-click the well and select include. The data must be reanalyzed.

5.6.2.3 If either standard curve cannot be adjusted to meet the criteria in **5.6.2.1**, the Forensic Scientist shall repeat the assay (i.e., both the human and the male curves must pass criteria). If limited sample exists, the Forensic Scientist shall consult with the DNA Technical Leader on how to proceed.

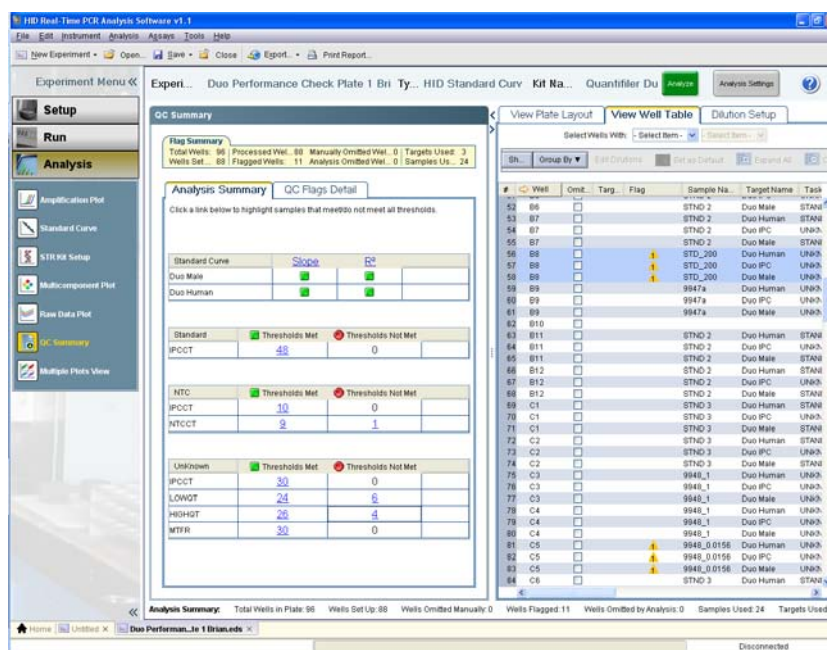
5.6.2.3.1 If an entire assay is not being used for analysis (i.e., the standard curve does not meet quality metric criteria in **5.6.2.1**), the data shall still be printed to PDF format (refer to the Forensic Biology Section Procedure for Documentation and Review for file naming). This PDF shall include: the Setup Worksheet, the standard curve(s) and the results. A Dilution Worksheet (see **5.7**) shall not be required in this instance.

5.6.2.3.2 If an entire assay is not being used due to instrument or computer failure, no data may be generated; if no data is generated, only the Setup Worksheet is required (in PDF format).

5.6.2.4 If the standard curve is modified to meet the quality criteria, both the modified and unmodified standard curve(s) must be included in the assay PDF document. To print the standard curve(s), go to Print Report in the top menu bar and select only the Standard Curves option; use the Print2PDF printer. Refer to the Forensic Biology Procedure for Documentation and Review on the proper format for naming electronic documents in PDF format.

5.6.3 Assessing the Duo Human Data: In the Experiment Menu, go to Analysis and QC Summary. This page provides a snapshot of the data and automatically flags possible sample issues. In the Analysis Summary tab, any such samples are hyperlinked to the View Plate Layout on the right hand side of the screen. Within the View Plate Layout, flagged wells have a yellow triangle with an exclamation point.

5.6.3.1 Highlight the well(s) of interest in the View Plate Layout tab, and then select the View Well Table tab. The wells will be highlighted a darker blue in this tab (scroll through):



5.6.3.2 Forensic Scientists shall assess the quality of the data of the samples and controls by evaluating the IPC and Duo (human and male) results. A general guide:

Duo Human (VIC® Dye) and/or Duo Male (FAM™ Dye)	Duo IPC (NED™ Dye)	Interpretation
No amplification	Amplification	True negative (no human DNA detected)
No amplification	No amplification	Invalid result
Amplification (low C_T and high delta R_n)	No amplification or C_T higher than 31	IPC result inconclusive
Amplification (high C_T and low delta R_n)	No amplification	PCR inhibition

5.6.3.3 NTC - Due to the sensitivity of the real-time PCR method, extremely low levels of DNA (levels that do not affect downstream applications such as STR analysis) can be detected. Therefore, if a C_T value of 36 or greater is observed in either the Duo Human or Duo Male detectors, it is still considered to be a negative sample and the results of the assay are still valid (assuming the Duo IPC result is valid). However, if the C_T value of either the Duo Human or Duo Male detectors in the NTC is less than 36 the NTC sample **may** be repeated based on the training and

experience of the Forensic Scientist. If the other negative controls within the same assay show C_T values greater than 36, the Forensic Scientist may proceed with the amplification of the samples.

5.6.3.4 Negative Controls – If the C_T value of a negative extraction control (for either the Duo Human or Duo Male detectors) is less than 36, the Forensic Scientist may continue processing the samples, realizing that DNA may be observed in those controls when amplified.

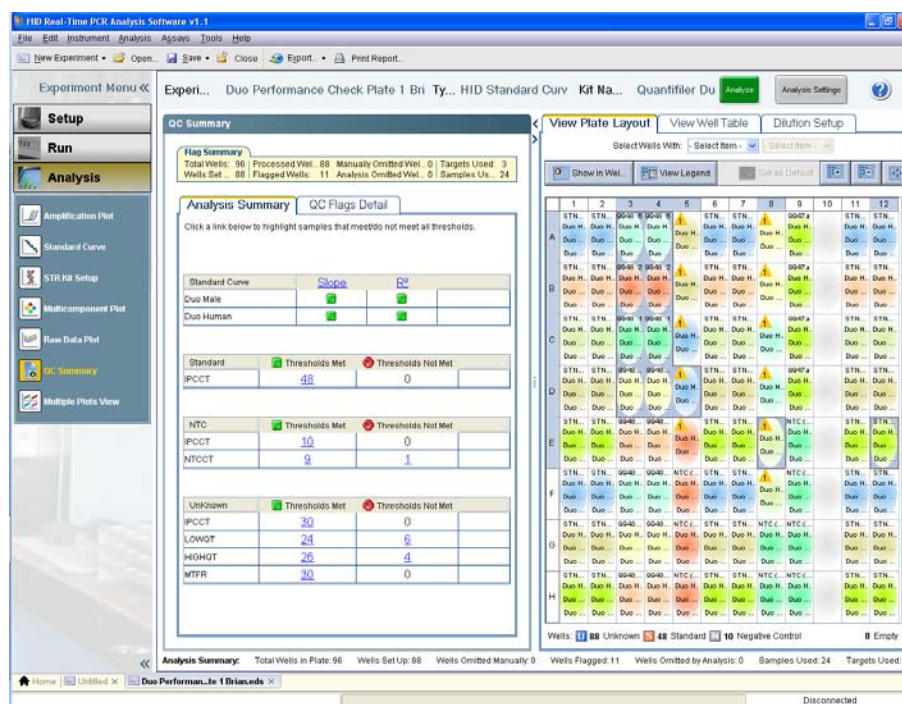
5.6.3.5 Samples – Samples shall be evaluated by taking the IPC results into consideration

5.6.3.5.1 Invalid IPC: if both the IPC and the human/male targets fail to amplify (undet.), then it is not possible to distinguish between the absence of DNA, PCR reaction failure, or inhibition. Such samples shall be re-quantitated with dilutions (unless a dilution of the sample has been quantitated and valid IPC results were obtained).

5.6.3.5.2 Inconclusive IPC: if extremely high concentrations of DNA are present in a sample, competition between the human/male targets and the IPC for PCR reagents may suppress the IPC, which results in a low C_T for the human/male targets and a C_T higher than 31 or undet. for the IPC. (Note: this situation is not necessarily inhibition and therefore no notations shall be made as such.) Alternatively, if the C_T is high for the human/male target as well as the IPC, then inhibition may be present. Inhibition may also be indicated when the C_T is undet. for the IPC and the C_T is high for the human/male targets.

5.6.3.5.3 Negative Sample: If the C_T for the IPC is within the acceptable range (28 to 31) and the human/male targets are undet., then this is a true negative sample (i.e., no DNA is present).

5.6.4 To print the results for each case, in any of the options under the Analysis menu, highlight the NTC and only the samples per case in the View Plate Layout map on the right hand side of the screen:



5.6.4.1 At the top of the screen in the menu bar, select Print Report. Select only the Results Table (By Well). Print the report in PDF format and add it to the PDF of the standard curve(s) generated previously.

5.6.5 To export the data, in the Experiment Menu, go to Analysis. In the View Plate Layout tab, select the entire plate.

5.6.5.1 From the top of the screen in the menu bar, select Export.

5.6.5.2 Within the Export Properties tab, only the Results box should be selected under line 1. Under line 2, only one file should be selected. In line 3, the Forensic Scientist shall choose a location to export the data for use in Excel. Note: the correct file type for the exported data is .xls.

5.6.5.3 Select Start Export. When the export has been completed, the HID software will ask “What do you want to do next?” Select Close Export Tool if finished or, Export More Data if additional files require exporting.

5.6.6 If multiple cases were run in the same assay, then a raw data file (.eds) shall be created for each case and shall not contain sample information from the batched cases.

5.6.6.1 To create raw data files specific to each case, go to the Experiment Menu and then to Setup and Plate Setup.

5.6.6.2 Immediately save a copy of the .eds file for each case (perform Save As). Name the .eds file(s) as described in the Procedure for Documentation and Review (i.e.,

1_R201012345_3_raw data). DO NOT OVERWRITE THE ORIGINAL .EDS FILE.

5.6.6.3 In the Assign Targets and Sample tab, using the View Plate Layout view, select the well(s) to be deleted. Right-click and select clear. Note: choosing omit instead of clear will not remove the data from the file. Reanalyze the data and save the .eds file.

5.6.6.4 Add the raw data file(s) to the object repositories for each case record. The case-specific .eds files, as well as any PDF documents generated from the Forensic Analyst, may be removed from the computer.

5.6.7 Close the HID software. Open the 7500 instrument door and remove the optical plate. Dispose of the plate in the biohazard waste. Close the instrument door and shut off the instrument.

5.7 Analysis of Quantifiler Duo Data in Microsoft Excel

5.7.1 Open the exported results from 5.6.5 in Excel.

5.7.2 Open the Quantifiler Duo Dilution Calculation Worksheet (Dilution Worksheet) in Excel. Copy the data from 5.7.1 into the Raw Data tab of the Dilution Worksheet.

5.7.3 In the Dilution Worksheet tab, the data is now present in the upper portion of the worksheet. For each case, copy the NTC and associated case samples (highlighting the sample names only) and paste them into the Dilution Calculation Worksheet (Human) portion below (use Paste Special, Values). Samples > 2 ng/μl need to be diluted; therefore, those samples shall be placed in the top dilution calculator.

- 5.7.4 The Dilution Worksheet automatically calculates the amount of DNA to add to a 1ng Identifiler® Plus PCR reaction. For samples which require dilution due to large quantities, the Dilution Worksheet provides the amounts necessary to create a 1ng/μl dilution. Note: the Dilution Worksheet allows the Forensic Scientist to adjust the raw extract volume to be used in making the dilution, but is set to default with 5 μl.
- 5.7.5 Print the Dilution Worksheet as a PDF and add it to the PDF file(s) generated with the Setup Worksheet, standard curve, and results. The Dilution Worksheet provides the information necessary to perform Identifiler® Plus PCR reactions.
- 5.7.6 Close Excel. Log off the computer.

5.8.1 Refer to the Procedure for Calibration and Equipment Maintenance.

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5.9 Quality Control of the Quantifiler Duo Kit

5.9.1 Refer to the Procedure for DNA Reagent Preparation and Quality Control.

6.0 Limitations – N/A

7.0 Safety – N/A

8.0 References

Forensic Biology Section Procedure for Documentation and Review

Forensic Biology Section Procedure for Calibration and Equipment Maintenance

Forensic Biology Section Procedure for DNA Reagent Preparation and Quality Control
Quantifiler® Duo DNA Quantification Kit User's Manual (PN 4391294, Rev C), 2008 Applied Biosystems

Applied Biosystems 7500/7500 Fast Real-Time PCR Systems System Maintenance (PN 4387777 Rev. D), 2010 Applied Biosystems

9.0 Records – N/A

10.0 Attachments – N/A

Revision History		
Effective Date	Version Number	Reason
01/03/2013	1	Original Document
07/31/2013	2	5.3.1 – changed 4 case batch limit to sample limit of 30 samples at a time; 5.3.3 – removed; 5.6.4 – removed “(if batched)” language