

# TADM Programmer's Guide

## Table of Contents

1	General information .....	1
1.1	About this document .....	1
1.2	Prerequisite knowledge.....	1
1.3	Further information.....	1
2	Installation.....	3
3	The TADM Principle .....	5
3.1	Introduction .....	5
3.2	TADM curves .....	6
3.2.1	Technical aspects .....	6
3.3	Pipetting errors.....	10
3.3.1	Possible pipetting errors during aspiration.....	10
3.3.2	Possible pipetting errors during dispensing .....	11
3.3.3	Summary .....	11
4	Step by step using TADM .....	13
4.1	Introduction .....	13
4.2	Methodology .....	14
4.3	Recording of pipetting curves.....	15
4.3.1	Instrument settings.....	15
4.3.2	Enabling TADM for the liquid class.....	16
4.4	Preparing the method.....	18
4.5	Analyzing TADM curves .....	19
4.5.1	Viewing of TADM Curves .....	19
4.5.2	Characteristics of TADM curves.....	22
4.6	Defining the TADM Tolerance Band.....	24
4.6.1	Defining the TADM Tolerance Band for single pipetting .....	24
4.6.2	Defining the TADM Tolerance Band for Dispense on the Fly.....	26
4.6.3	General rules for defining the TADM Tolerance Band .....	29
4.7	Interpreting the TADM pressure curves.....	30
4.8	Working with TADM .....	30
5	The TADM Tolerance Band Editor .....	31
5.1	Overview.....	31
5.2	Menu details .....	32
6	Glossary.....	35

# TADM Programmer's Guide

# TADM Programmer's Guide

---

## 1 General information

This chapter should be read thoroughly before applying the *Total Aspiration and Dispense Monitoring (TADM)* feature. It contains important information about the use of TADM and this document.

All features described in this document are valid for TADM only. Refer to the corresponding manuals for programming and operating instruments controlled by the MICROLAB STAR Line Software.

The TADM feature 5.1 supports all pipetting channels such as the (old) 300ul channel, the 1000ul channel, the 5ml channel and the 96 CO-RE head TADM. The 384 CO-RE head does not have individual pressure sensors on each channel and does therefore not support TADM.

### 1.1 About this document

The *TADM Programmer's Guide* shows you step by step how to get more out of your system by using *TADM*. When you have worked through this document, you should be able to understand the mechanism of TADM, in order to implement and use it in your application.

The *TADM Programmer's Guide* is an addendum to the MICROLAB STAR Line manuals. It provides a guideline on how to use TADM. As each liquid has its own characteristics, you may find some deviation from the indications in this document when you define the TADM tolerance bands for your specific application. This is due to the fact that not all variations and liquid-specific characteristics can be considered.

This document is intended to be used with MICROLAB STAR Line software VENUS two base package 4.3 or above unless stated otherwise.

The manuals for programming and operating MICROLAB STAR Line instruments controlled by the MICROLAB STAR Line software contain mandatory basic information.

### 1.2 Prerequisite knowledge

In order to be able to use *TADM* successfully and safely, the programmer must be familiar with the HAMILTON MICROLAB STAR Line VENUS software, must understand the laboratory process which is automated, and must have taken appropriate Hamilton-authorized training on a MICROLAB STAR Line instrument.

### 1.3 Further information

Further information can be found in the MICROLAB STAR Line manuals as well as in the online help.

# TADM Programmer's Guide

## 2 Installation

1. Insert the VENUS TADM feature software installation disk in the CD or DVD drive. The installation starts automatically.
2. Follow the instructions of the installation program.



### **ATTENTION**

*The installation of the TADM software has to be done after the installation of the main software (the MICROLAB STAR VENUS software).*



### **NOTE**

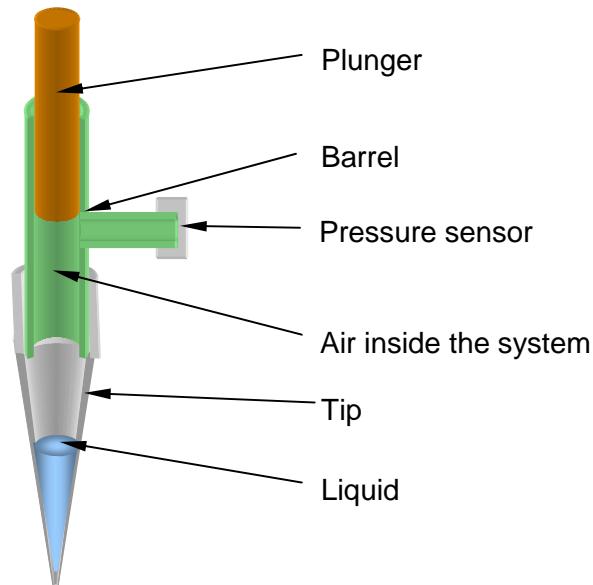
*If the installation does not start automatically, start it using the Windows program execution function (menu "Start" – "Run").*

# TADM Programmer's Guide

## 3 The TADM Principle

### 3.1 Introduction

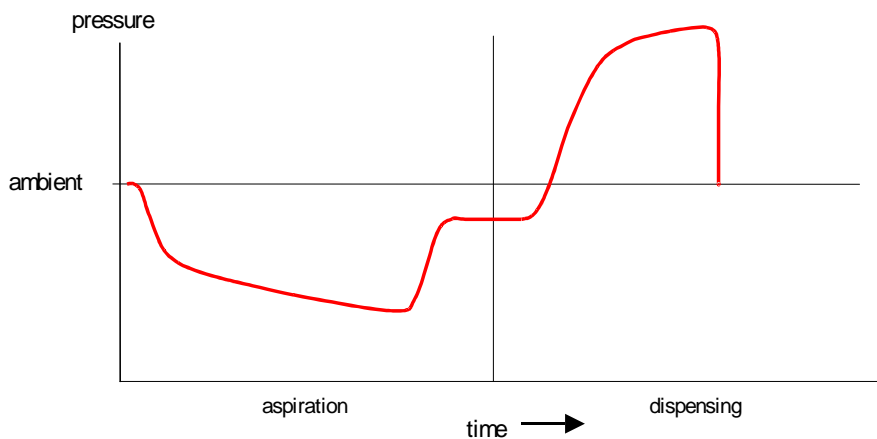
TADM (Total Aspiration and Dispense Monitoring) is a tool to increase the safety and the robustness of pipetting processes. A pressure sensor inside each individual pipetting channel constantly records the pressure in the system during aspiration and dispensing.



**Fig. 1: Air displacement system with pressure sensor for TADM**

The software generates a pressure / time curve (See Fig. 2) that is different for each liquid (class) and each volume pipetted. The values obtained by the pressure sensor during a pipetting step (aspiration or dispensing) can be compared to user-defined values, which means real-time monitoring of the pipetting process.

Generally, TADM is best operated for volumes between 10 $\mu$ l and 1000 $\mu$ l on 1000 $\mu$ l channels (50 $\mu$ l - 5000 $\mu$ l on 5ml channels) when pipetting serum, plasma, or other water-based liquids. However, depending on the specific requirements of an application, other volumes and liquids may be used as well.

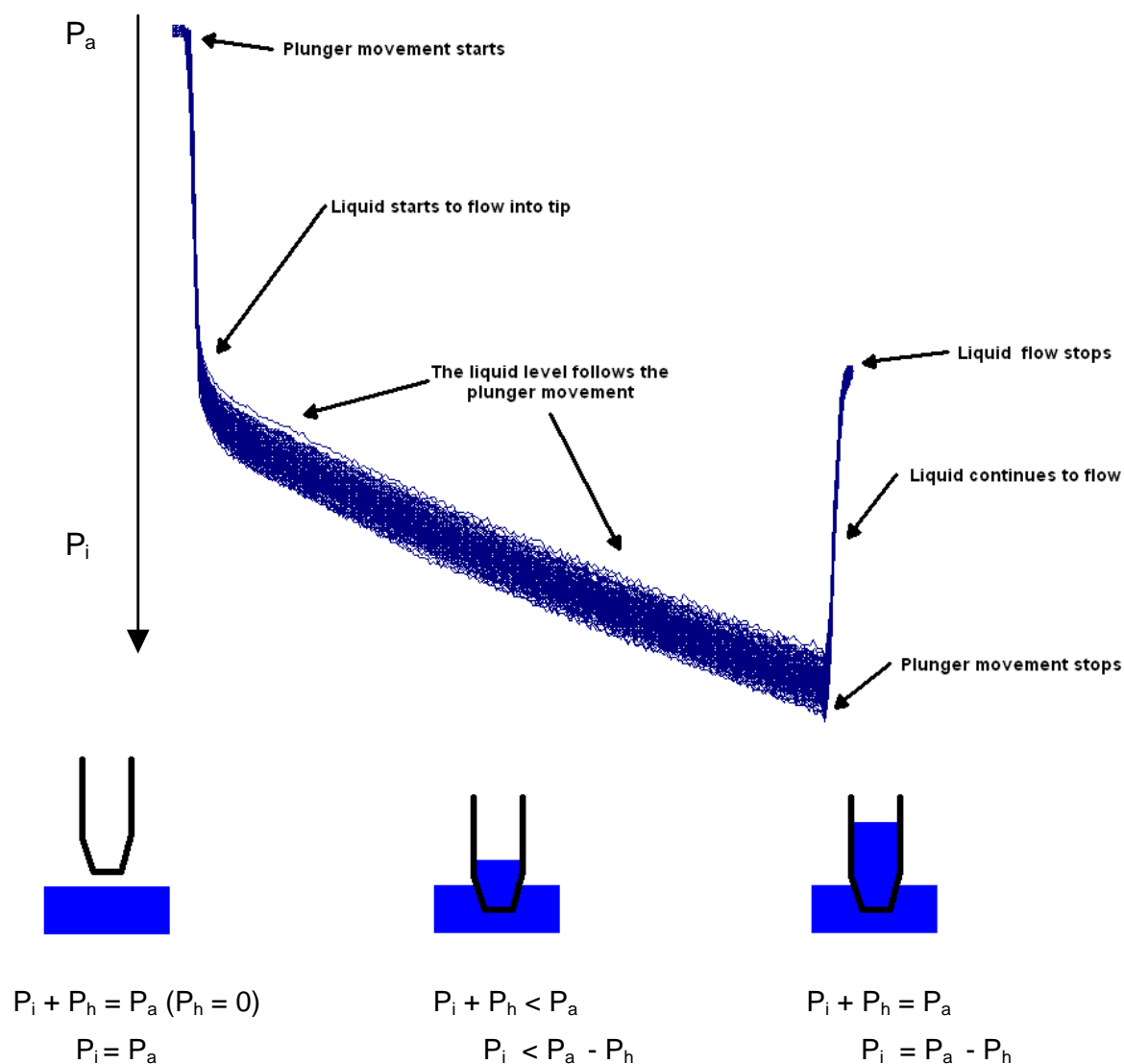


**Fig. 2: Pressure signal over time**

## 3.2 TADM curves

### 3.2.1 Technical aspects

Figure 3 and Figure 4 explain in detail how the mechanical movement of the plunger influences the flow of liquid inside the tip and the shape of the resulting pressure curve for an aspiration or a dispense step. The lower part of Figure 3 and Figure 4 contain schematic drawings of the situation within the tip at the start, during, and at the end of the pipetting step ( $P_i$  = air pressure inside the tip,  $P_h$  = hydrostatic pressure inside the tip,  $P_a$  = ambient air pressure).



**Fig. 3: TADM curves: Aspiration**



# TADM Programmer's Guide

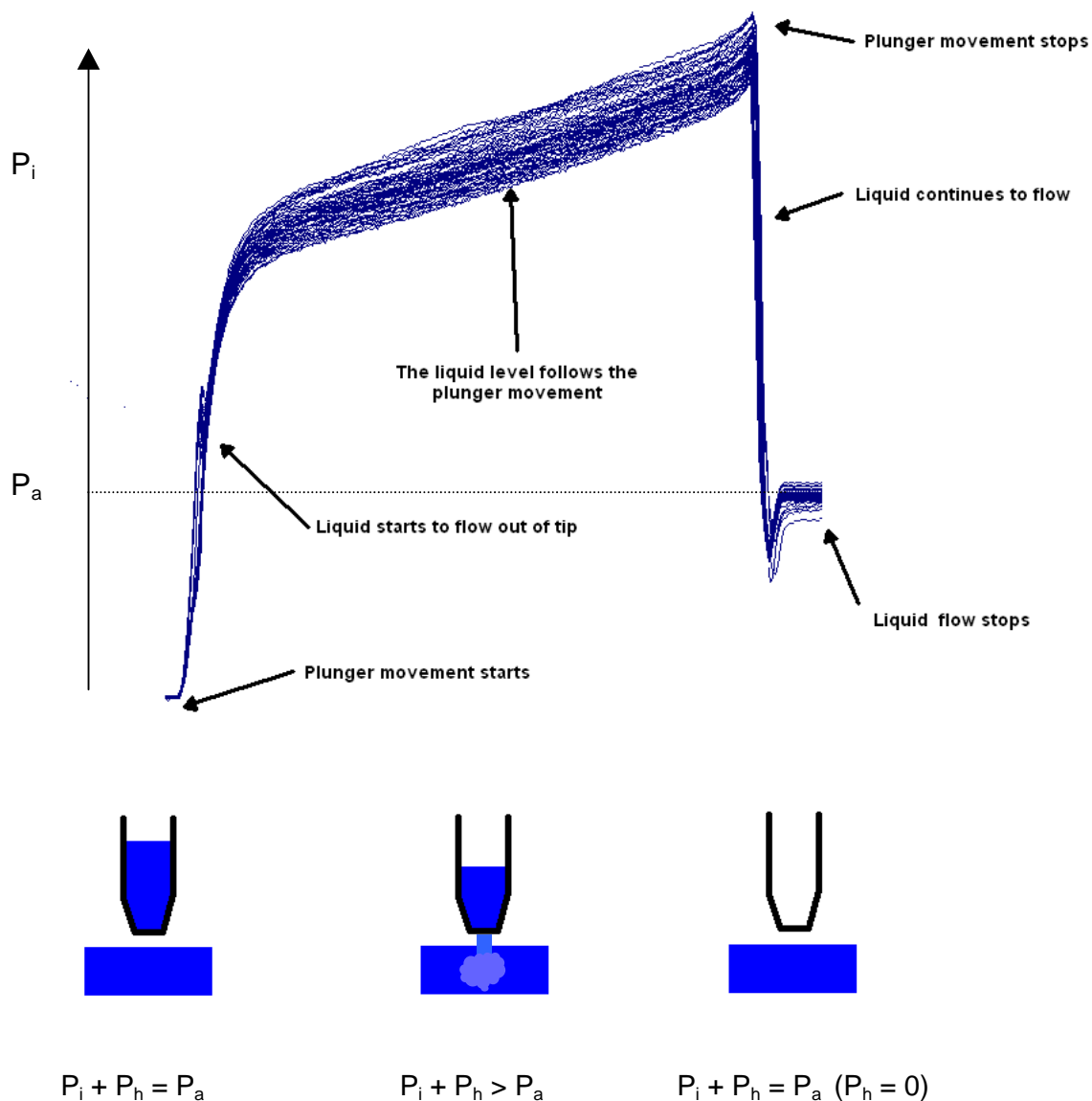
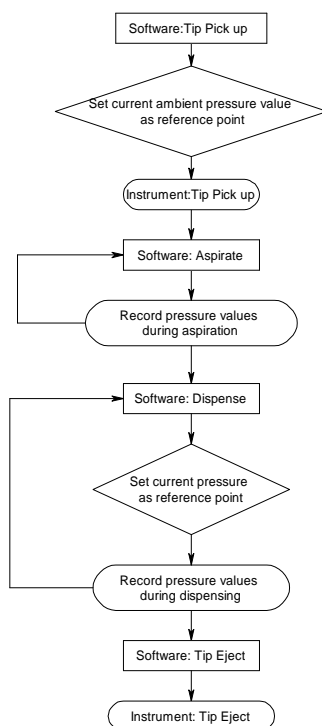


Fig. 4: TADM curves: Dispense

Obviously, the TADM feature would not be feasible if the pressure curves obtained were instrument-, weather- and altitude-dependent. Therefore, the reference point of the pressure curve is zeroed automatically by the software before pipetting commands are executed.

# TADM Programmer's Guide

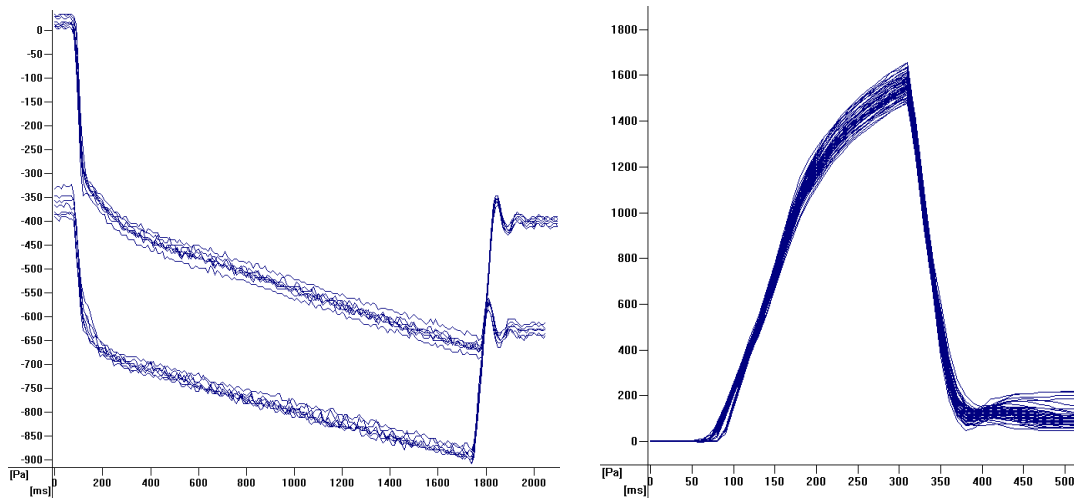
Figure 5 explains at what time the reference point for the pressure curves is zeroed depending on whether an aspiration or a dispense step is programmed. This is important to know if consecutive aspiration or dispensing (aliquoting) steps use the same liquid class and volume.



**Fig. 5: Pressure value adjustments for aspiration and dispense steps**

Because the pressure value is not re-zeroed between consecutive aspiration steps, TADM curves from the different aspiration cycles will be shifted, as can be seen in Figure 6 (left side, 2 aspirations of 400 $\mu$ l each). In other words, the reference point for the start of an aspiration curve will always be the pressure value obtained before the tip was picked up. Since the pressure value is re-zeroed between consecutive dispensing steps, curves as seen in Figure 6 (right side, dispensing 100  $\mu$ l 8 times) will be obtained, where the curves from all consecutive dispense cycles are not shifted.

# TADM Programmer's Guide



**Fig. 6: Consecutive aspiration and dispense steps and the resulting TADM curves**



## **NOTE**

*In order to use TADM tolerance bands for an aspiration step such as in Figure 6, different liquid classes have to be used for the individual aspiration steps*

## 3.3 Pipetting errors

By examining the TADM curves of many aspiration or dispense steps, it becomes apparent that curves obtained from a normal, error-free pipetting step are distinctively different from curves from erroneous pipetting steps. These differences are quite obvious and can be used to distinguish between correct and erroneous pipetting steps.

The following two figures show the different types of TADM curves that can be obtained during aspiration and dispense steps respectively. Basically, there are two different types of scenarios that can be detected:

- Pressure above normal
- Pressure below normal

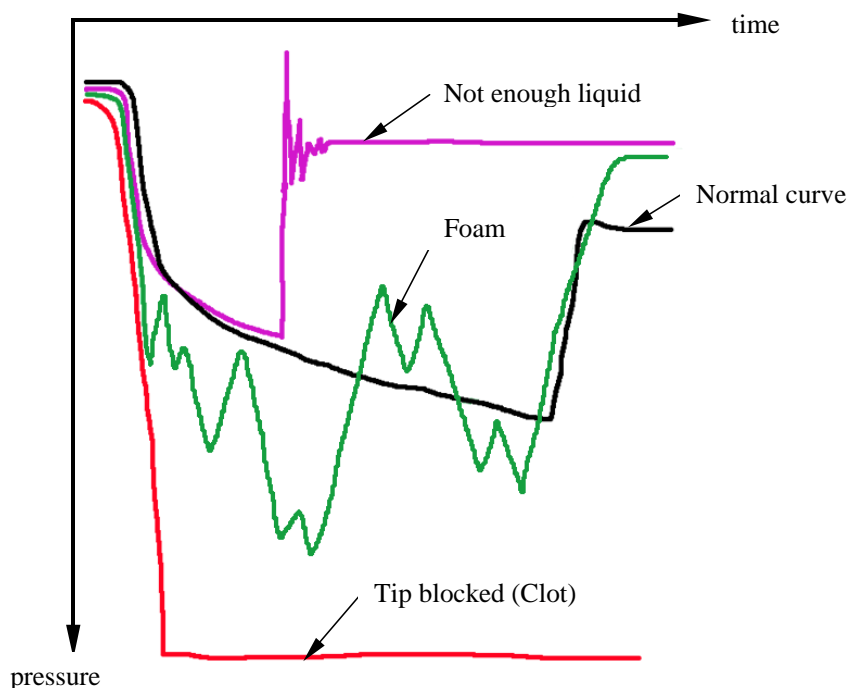
The type of pipetting step (aspiration or dispensing) influences what kind of scenario a specific error produces. For example, a blocked tip will produce pressure below normal during aspiration and pressure above normal during dispensing, while a short sample will produce pressure above normal during aspiration and pressure below normal during dispensing.



### NOTE

*The vast majority of pipetting errors will be detected during the aspiration step. Foam can behave rather unpredictably and can produce pressure above as well as pressure below normal errors during aspiration and / or dispensing”).*

### 3.3.1 Possible pipetting errors during aspiration



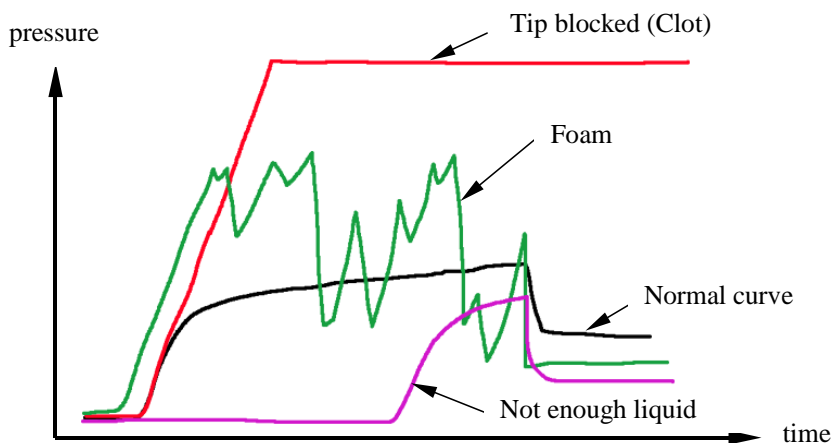
**Fig. 7: Typical TADM curves for correct and erroneous aspiration steps**

A pressure value below the normal, error-free aspiration curve means that the pressure decreases because as the plunger continues to move inside the channel, the liquid level inside the tip does not. A pressure signal above the error-free curve signifies that as the

# TADM Programmer's Guide

plunger moves inside the channel, the liquid that enters the tip has less resistance than the reference liquid.

### 3.3.2 Possible pipetting errors during dispensing



**Fig. 8: Typical TADM curves for correct and erroneous dispensing steps**

A pressure value above the error-free dispensing curve means that the pressure increases because as the plunger continues to move inside the channel, the liquid level inside the tip does not. A pressure signal below the error-free curve signifies that as the plunger pushes the air inside the channel, the liquid that leaves the tip has less resistance than the reference liquid.

### 3.3.3 Summary

Below is a summary table showing the correlation between pipetting errors and the resulting pressure curves during either aspiration or dispensing.

Pipetting step	Error type	Pressure curve
aspiration	clot detected	pressure below normal
	no or short sample	pressure above normal
	foam	'zig-zag' behavior, pressure above/below normal
	leaky system	pressure above normal
dispensing	blocked tip	pressure above normal
	not enough liquid	retarded rise in pressure, pressure below normal
	foam	'zig-zag' behavior, pressure above/below normal
	leaky system	pressure below normal

# TADM Programmer's Guide

## 4 Step by step using TADM

### 4.1 Introduction

The TADM principle can be used in two different ways:

- 1) Recording mode: The pressure inside the pipetting channel is **recorded only**.
- 2) Monitoring mode: The pressure inside the pipetting channel is constantly **recorded and compared** to a predefined tolerance value. If the measured value exceeds the tolerance, the plunger movement stops immediately and the software-dependent error handling is executed.

However, special attention has to be paid to a number of settings that can influence the effectiveness and behavior of TADM (see Figure 9 below).

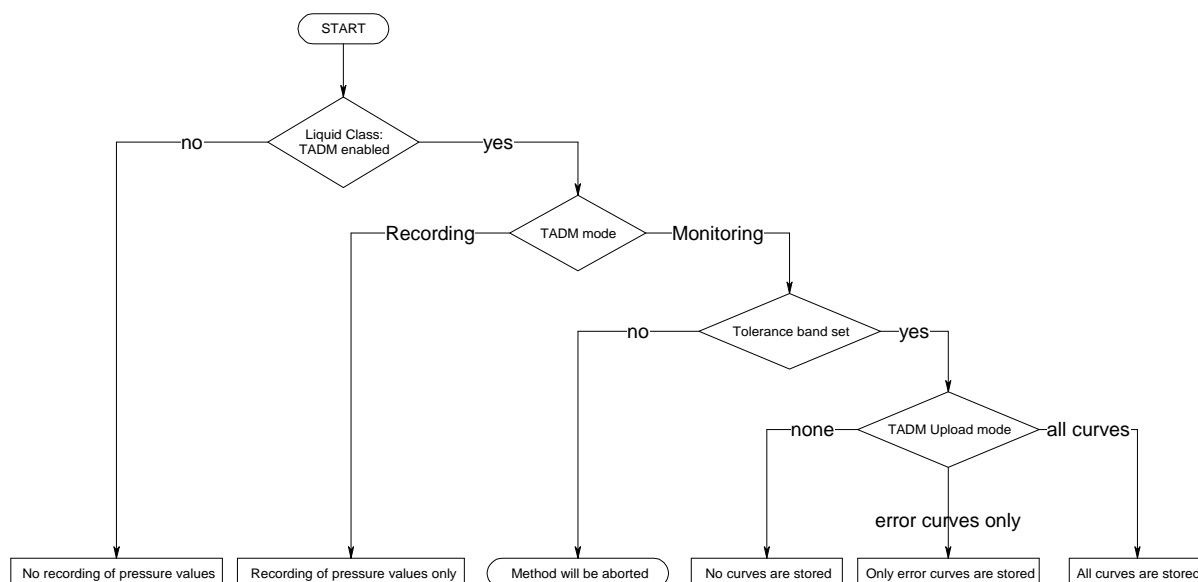


Fig. 9: TADM settings and modes



#### ATTENTION

*If TADM is not enabled for the liquid class, no TADM monitoring will take place for this liquid class even if the TADM mode is set to monitoring.*

*If a tolerance band has not been defined for a specific volume used during pipetting in TADM monitoring mode, the run will be aborted.*



#### NOTE

*The temperature of the liquid can have a significant influence on the pressure curve. It is mandatory that the liquid used for recording the reference pressure curves have the same temperature as the liquid used during routine work.*

## **4.2 Methodology**

In order to increase the safety and robustness of the pipetting process, the following guidelines have to be followed for setting TADM tolerance bands.

### **1) Define the pipetting strategy**

Although setting the TADM tolerance bands is the last stage of application development, the liquid handling process must be defined as early as possible during development, because the implementation of liquid handling in the application may have a huge impact on the method programming.

### **2) Set up a robust process**

Before the TADM tolerance bands for a specific liquid and volume can be set, a precise and robust pipetting process has to be established. This involves the liquid class (accuracy and precision according to requirements) and the pipetting strategy (surface or jet mode, etc.) itself.

### **3) Get TADM data**

After the pipetting process has been established, a minimum of 20 curves per channel should be recorded in TADM recording mode in order to collect a significant number of data points. These sample curves provide the basis for setting the TADM tolerance bands – therefore the samples used should be checked carefully for the absence of clots, foam, etc.

### **4) Set tolerance bands**

After the standard curves have been recorded, the TADM tolerance bands must be set (see Chapter 4.6).

### **5) Check settings with 'bad' samples**

In order to check whether the TADM tolerance bands provide a safe and robust process, a run using stressed samples (foam, clots, etc.) must be performed in TADM monitoring mode.

### **6) Perform periodic checks**

It is recommended that you verify the usefulness of the TADM tolerance bands in routine operation (about every 3 to 6 months), especially if a lot of pipetting errors occur. This can be a sign that the TADM tolerance bands are set too narrow or are inadequate.



# TADM Programmer's Guide

## 4.3 Recording of pipetting curves

### 4.3.1 Instrument settings

During the development and testing phase, the instrument should be set to "TADM recording mode". This has to be set in the System Configuration Editor, which can be found under the "Tools" menu from the Method Editor.

The settings for the TADM modes / TADM Upload Modes can be set individually for every pipetting device such as 1000ul channels, 5ml channels and the CO-RE 96 Head.

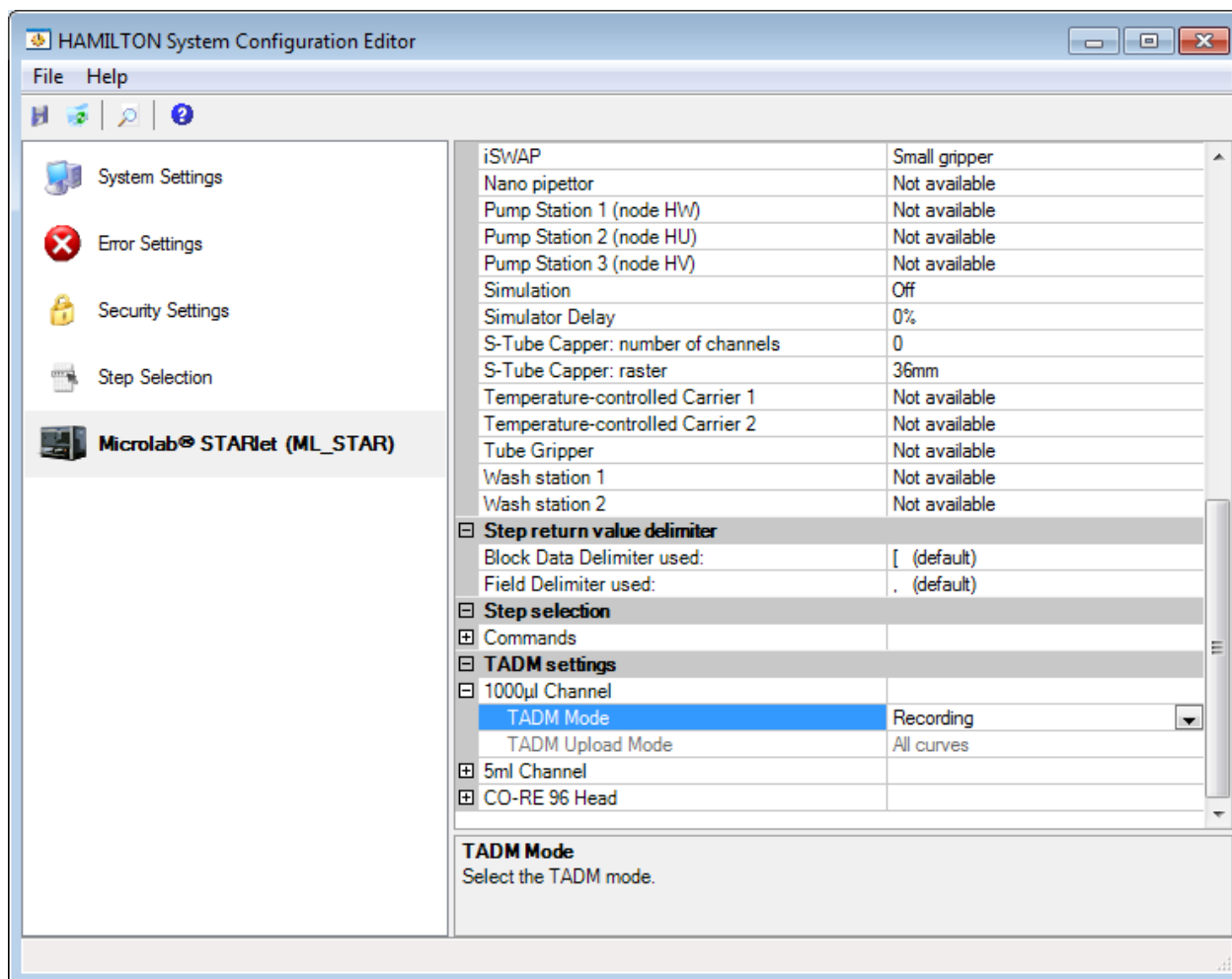


Fig. 10: System Configuration Editor: TADM settings

Select your instrument (STAR, STARlet, STARplus) in the left of the window, and then scroll down the right side of the window to the entry "TADM settings". Change "TADM Mode" to "Recording" for the desired pipetting devices. Close the System Configuration Editor and save the changes.

Refer to figure 9 for an explanation of the different settings.

# TADM Programmer's Guide

## 4.3.2 Enabling TADM for the liquid class

To use the TADM feature, the used liquid classes have to be prepared for that. In order to do this, start the Liquid Editor. The "Liquid Classes" window lists all liquid classes available and also shows whether TADM is enabled or disabled for a specific liquid class.



### NOTE

*All predefined liquid classes supplied by HAMILTON with the installation of the software have TADM disabled and are write-protected.*

*To have the TADM feature enabled, copy the desired predefined liquid class and then enable the TADM feature*

Select the desired predefined liquid class you want to copy and click the right mouse button. Click on 'Create'

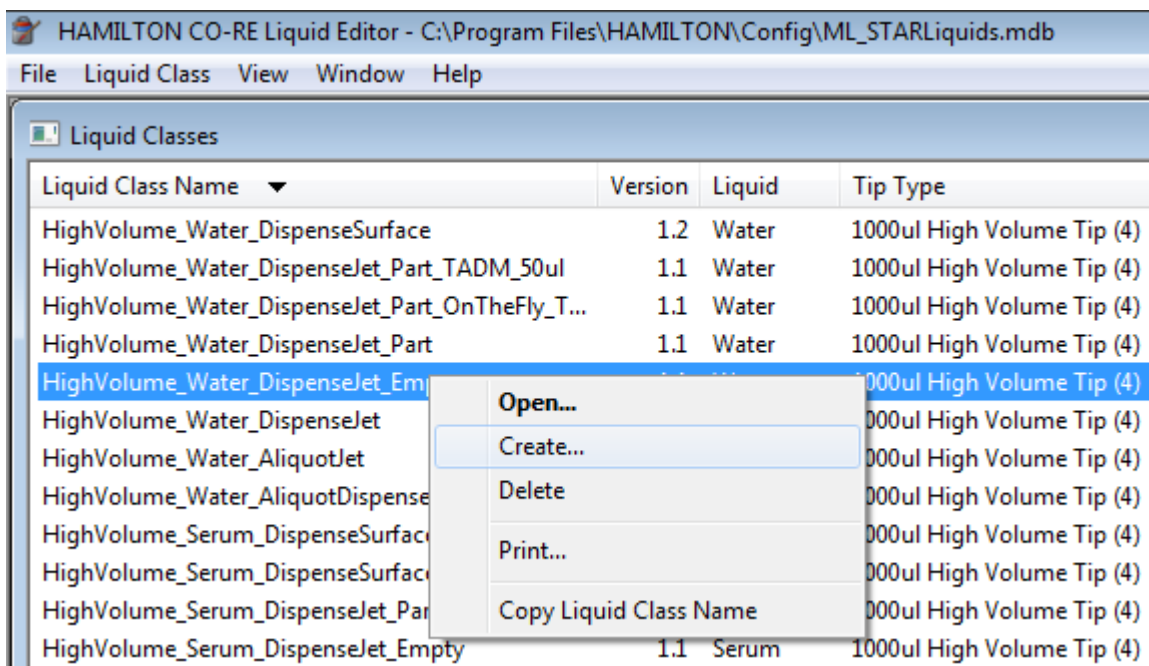


Fig. 11: Copying a predefined liquid class for TADM use

A dialog box opens to let you enter the name of the liquids class' copy:

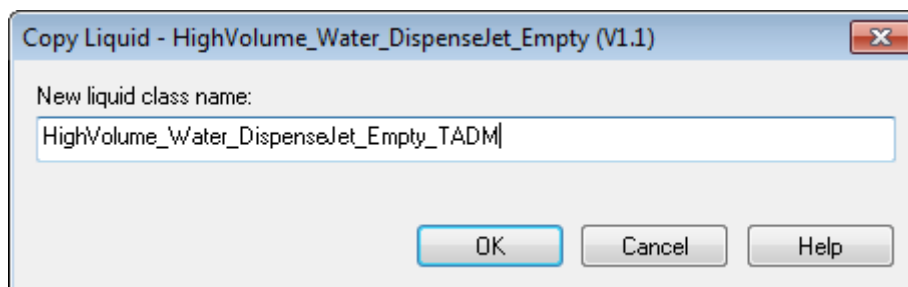
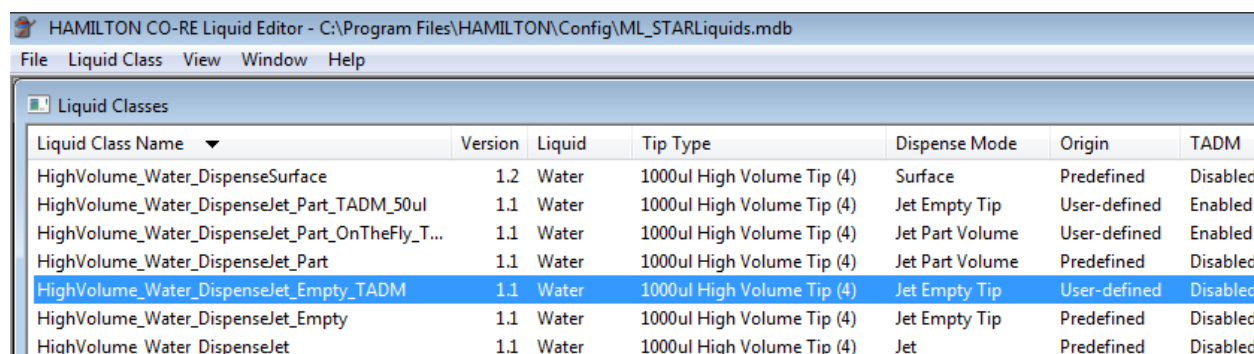


Fig. 12: Entering a name for the liquid class for TADM use

# TADM Programmer's Guide

Enter the new name (e.g. with suffix “\_TADM”) and close the dialog by clicking “OK”

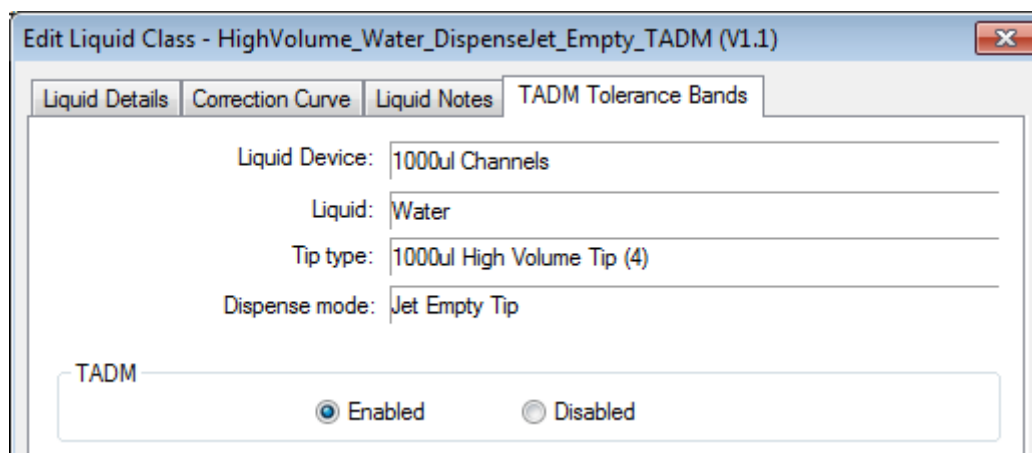
The newly created class will be added at the end of the list:



Liquid Class Name	Version	Liquid	Tip Type	Dispense Mode	Origin	TADM
HighVolume_Water_Dispen...Surface	1.2	Water	1000ul High Volume Tip (4)	Surface	Predefined	Disabled
HighVolume_Water_Dispen...TADM_50ul	1.1	Water	1000ul High Volume Tip (4)	Jet Empty Tip	User-defined	Enabled
HighVolume_Water_Dispen...OnTheFly_T...	1.1	Water	1000ul High Volume Tip (4)	Jet Part Volume	User-defined	Enabled
HighVolume_Water_Dispen...Part	1.1	Water	1000ul High Volume Tip (4)	Jet Part Volume	Predefined	Disabled
HighVolume_Water_Dispen...Empty_TADM	1.1	Water	1000ul High Volume Tip (4)	Jet Empty Tip	User-defined	Disabled
HighVolume_Water_Dispen...Empty	1.1	Water	1000ul High Volume Tip (4)	Jet Empty Tip	Predefined	Disabled
HighVolume_Water_Dispen...Jet	1.1	Water	1000ul High Volume Tip (4)	Jet	Predefined	Disabled

Fig. 13: The newly created liquid class is added to the list

Now, double click the name of the new liquid class for TADM use. The “Edit Liquid Class” window opens. Set the “TADM” radio button to “Enabled” and close the dialog → Click “OK”.



Edit Liquid Class - HighVolume\_Water\_Dispen...\_TADM (V1.1)

Liquid Device: 1000ul Channels

Liquid: Water

Tip type: 1000ul High Volume Tip (4)

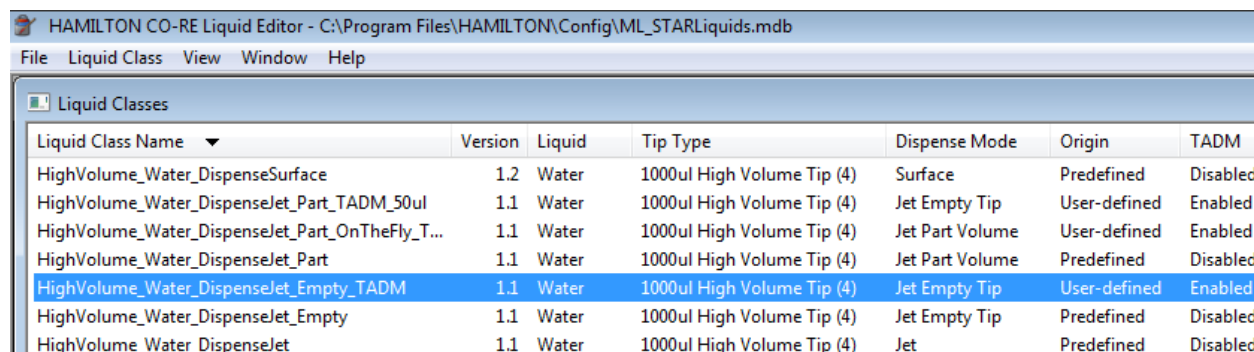
Dispense mode: Jet Empty Tip

TADM

Enabled  Disabled

Fig. 14: Edit Liquid Class: Enable "TADM"

Check if the liquid class' attribute for “TADM” is “Enabled”. You can also see that the “Origin” is “User-defined”:



Liquid Class Name	Version	Liquid	Tip Type	Dispense Mode	Origin	TADM
HighVolume_Water_Dispen...Surface	1.2	Water	1000ul High Volume Tip (4)	Surface	Predefined	Disabled
HighVolume_Water_Dispen...TADM_50ul	1.1	Water	1000ul High Volume Tip (4)	Jet Empty Tip	User-defined	Enabled
HighVolume_Water_Dispen...OnTheFly_T...	1.1	Water	1000ul High Volume Tip (4)	Jet Part Volume	User-defined	Enabled
HighVolume_Water_Dispen...Part	1.1	Water	1000ul High Volume Tip (4)	Jet Part Volume	Predefined	Disabled
HighVolume_Water_Dispen...Empty_TADM	1.1	Water	1000ul High Volume Tip (4)	Jet Empty Tip	User-defined	Enabled
HighVolume_Water_Dispen...Empty	1.1	Water	1000ul High Volume Tip (4)	Jet Empty Tip	Predefined	Disabled
HighVolume_Water_Dispen...Jet	1.1	Water	1000ul High Volume Tip (4)	Jet	Predefined	Disabled

Fig. 15: Liquid class is ready for "TADM"

The system is now ready to record TADM curves.

# TADM Programmer's Guide



## NOTE

The TADM feature 5.1 supports all pipetting channels such as the (old) 300ul channel, the 1000ul channel, the 5ml channel and the CO-RE 96 Head TADM.

The CO-RE head 384 does not have individual pressure sensors on each channel and does therefore not support TADM.

Use the Liquid device selection to make sure the liquid class supports the correct device:

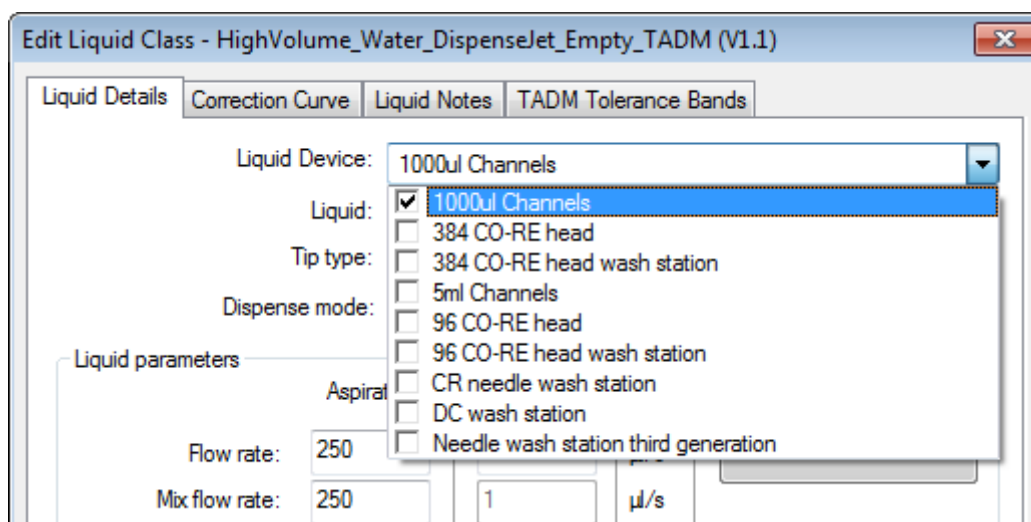


Fig. 16: Liquid device selection

## 4.4 Preparing the method

In order to record the reference pressure curves for setting the TADM tolerance bands, the application must have an established pipetting strategy that is both robust and precise. If the method is very large or time consuming to run, smaller methods can be prepared that contain the same pipetting steps like the original method. Original liquids and labware have to be used, and special care has to be taken to make sure that no pipetting errors occur.

## 4.5 Analyzing TADM curves

All pipetting steps of a run are traced and the relevant information like liquid class, pipetting mode (aspiration/dispensing, volume, channel number) is written into a single database.

### 4.5.1 Viewing of TADM Curves

After running the method in TADM recording mode, the pressure curves obtained can be viewed in the Liquid Editor. Start the liquid editor and double click on the liquid class that is to be analyzed. Select the "TADM Tolerance Bands" tab and then press the "Add from run..." button. All available runs are listed by method name and recording date.

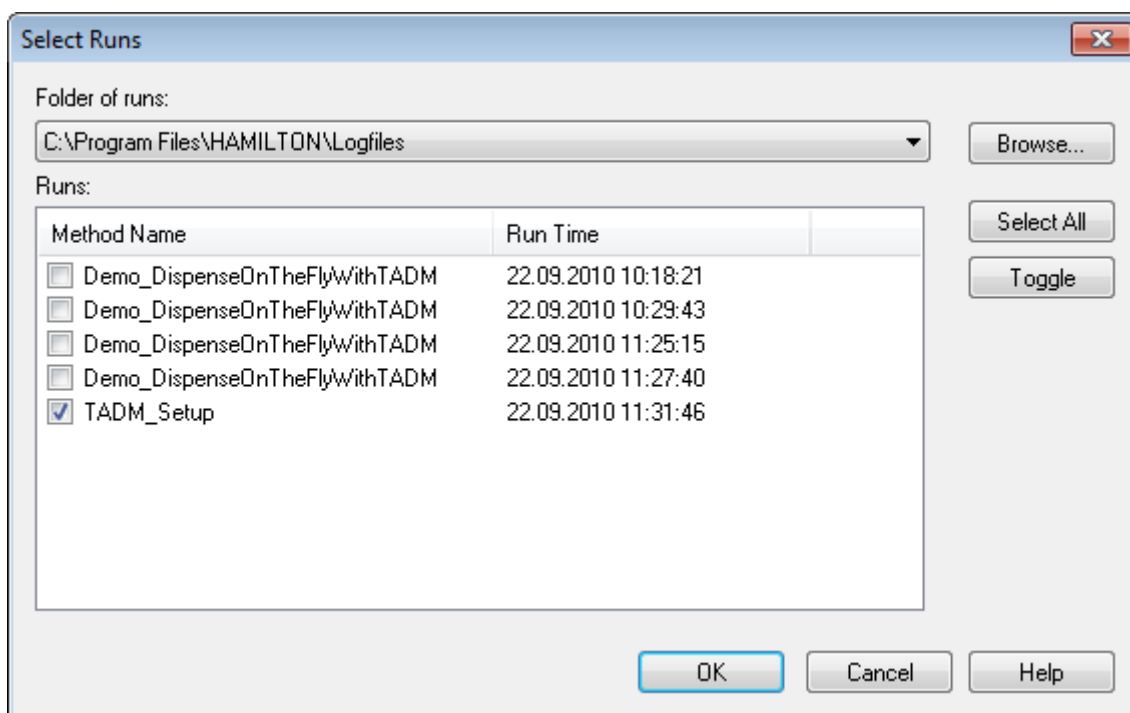


Fig. 17: Select Runs dialog box within the Liquid Editor

Select the desired runs by marking the check box and clicking "OK". There are several options and shortcuts available for selecting multiple runs:

- Shift: Select all runs between the selected one and the currently highlighted one
- Ctrl: Add only the currently highlighted run to the selection
- Ctrl+A: Select all runs in the list.
- Ctrl+C: Check the checkboxes of the selected runs in the list.
- Ctrl+T: Toggle checkbox state of the selected runs in the list.



#### NOTE

*A maximum of 60 runs can be selected simultaneously.*

# TADM Programmer's Guide

After pressing "OK", the selected runs will be searched for the specified liquid class and all aspiration and dispense volumes used will be listed (Figure 18).

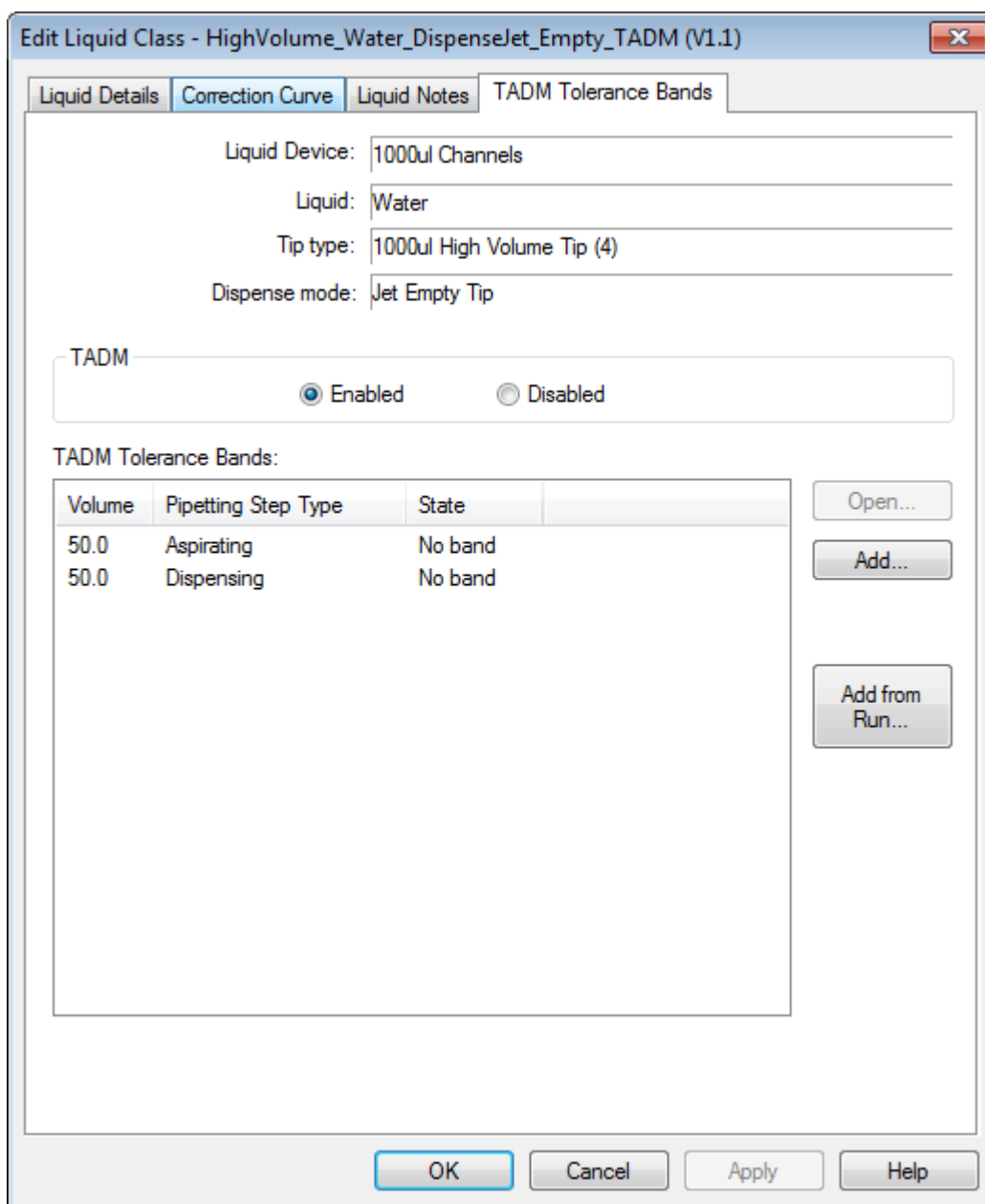


Fig. 18: Select a pipetting step to "Open..." the TADM Tolerance Band Editor

# TADM Programmer's Guide

Selecting a single pipetting step will enable the button "Open...". Double-clicking on a pipetting step, or pressing this button, will open the "TADM Tolerance Band Editor" window (for a detailed account of the editor see chapter 5):

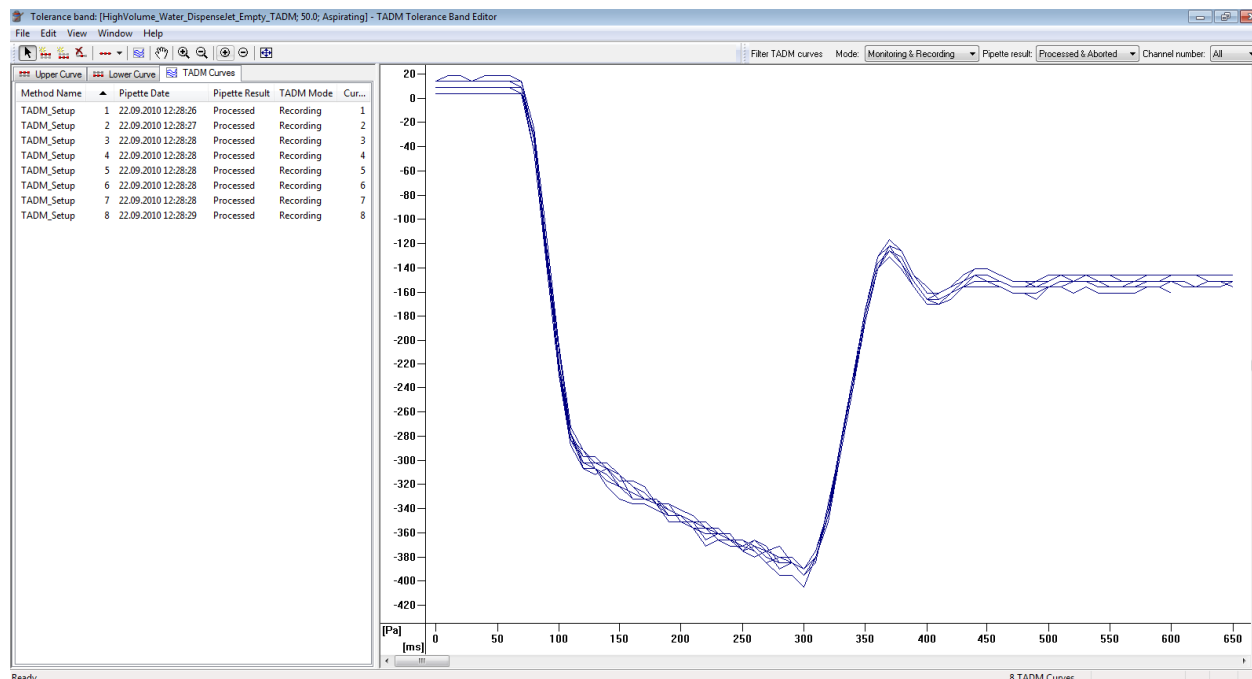


Fig. 19: The TADM Tolerance Band Editor

The title bar shows the selected liquid class, the volume and the pipetting mode. The window itself is divided into two frames. The right-hand one shows all curves for the selected volume and pipetting mode; the left-hand part of the window contains detailed information about the individual curves (pipetting time, channel number, TADM mode, etc).

The values are displayed as pressure [**P**ascal] over time [**m**illiseconds] curves.

## 4.5.2 Characteristics of TADM curves

TADM allows the analysis of pipetting steps and the resulting pressure curves in a qualitative way. It can therefore be a very helpful tool to optimize liquid handling.

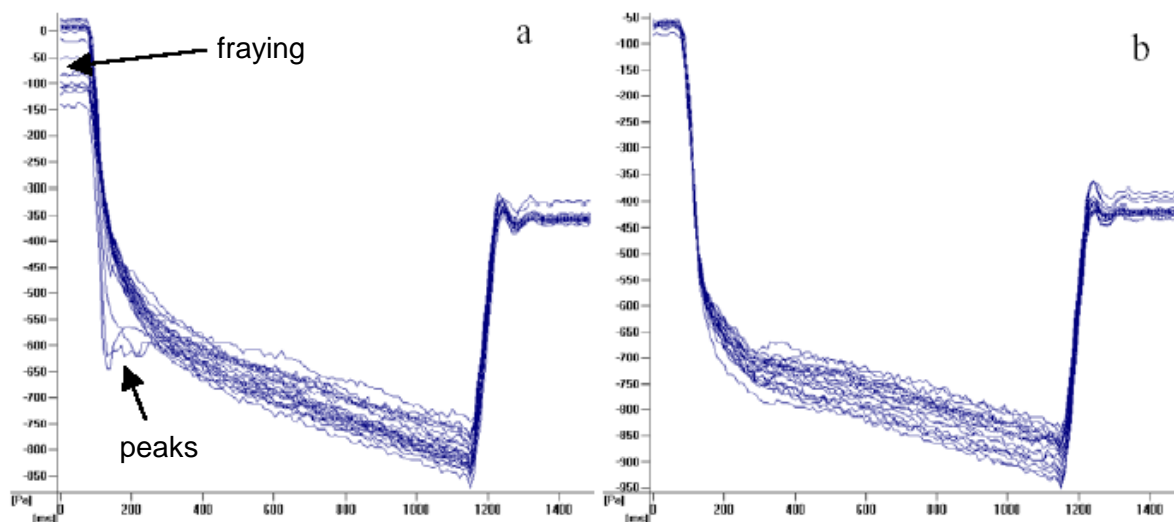


Fig. 20a: Uncorrected Aspiration

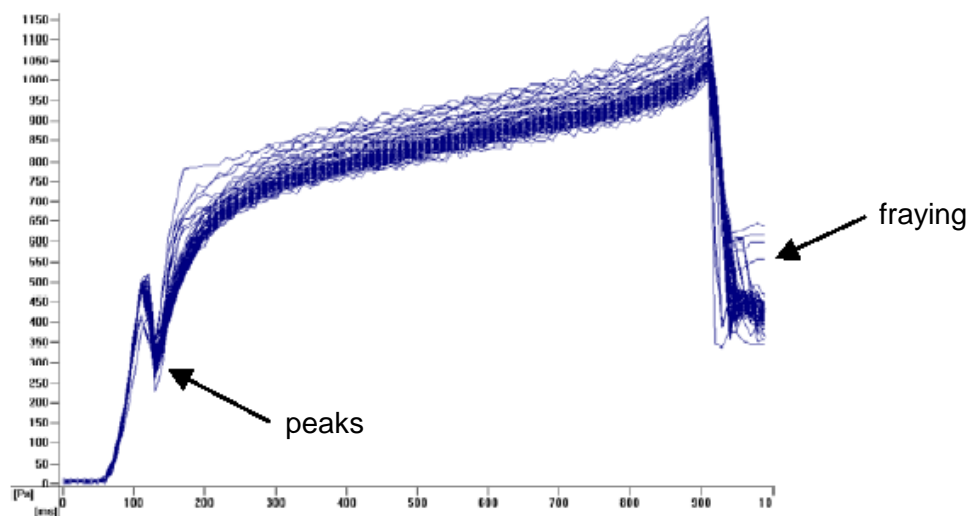
Fig. 20b: Optimized Aspiration

The peaks and the fraying of curves observed in Figure 20a (left picture) can be an indication that the liquid class and / or the pipetting steps are not defined in an optimal and robust way, but they can also be characteristic of the liquid used. In the example shown above, the pipetting process was not optimized. An adjustment of the pipetting parameters in the pipetting process resulted in the curves shown in Figure 20b (right picture).



## TADM Programmer's Guide

The following example shows typical curves for jet dispense steps.



**Fig. 21: Dispensing process**

The peak seen in the curves at 100ms in Figure 21 is typical for a dispense step and is not necessarily the result of sub-optimal settings. It actually reflects the dispensing of the transport air and the moment the liquid starts to leave the tip. The same holds true for the apparent fraying of the TADM curves at the end of the dispense step, which is the result of the blow-out volume and the resulting pressure inside the system.



### **NOTE**

*A narrow bundle of curves is not an indication that the pipetting process is precise and robust. Moreover, a precise and robust pipetting process does not guarantee closely bundled pressure curves.*

*TADM curves such as in Figure 20a can be - but do not have to be - an indication that the pipetting process is not robust and precise.*

## 4.6 Defining the TADM Tolerance Band

### 4.6.1 Defining the TADM Tolerance Band for single pipetting

Load a set of TADM curves into the TADM Tolerance Band Editor as shown in Figure 20.

- Choose *Add Upper Limit Curve Points* from the *Edit* menu or click on the  icon

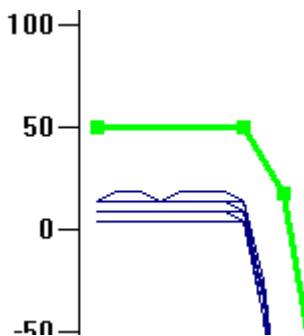


Fig. 22: Upper Limit Curve tolerance band

- It is recommended that you set the first curve point between the 0 and 100 Pascal value (Figure 22). A higher value may be required if wet tips are used for the aspiration (Figure 23). Place the next curve points where the TADM curves change directions. Special attention should be paid to the tolerance band at the beginning and the end of the pipetting step. Here, the tolerance band should follow the actual pressure curve rather closely, while the distance between curves and tolerance band should be wider during the remaining phase of the pipetting step.

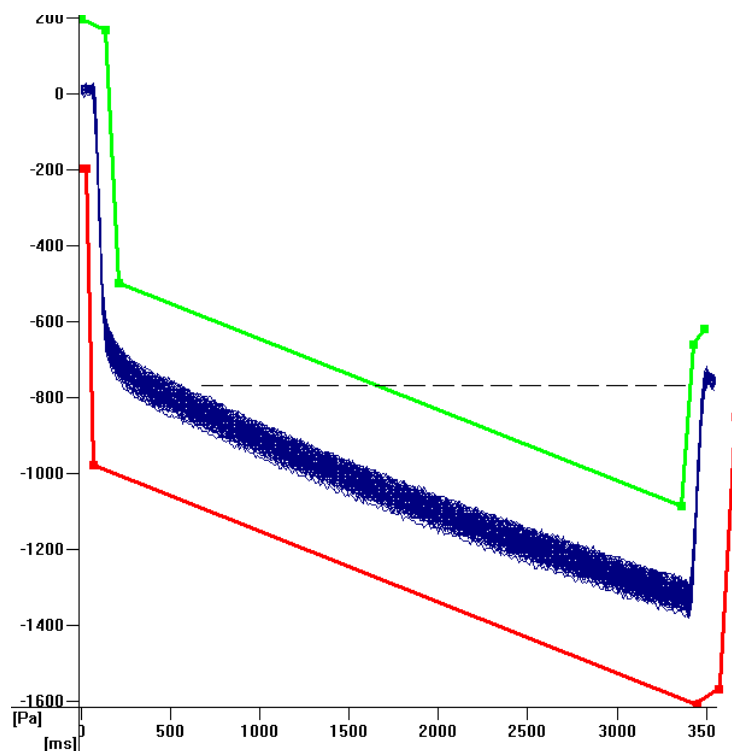





Fig. 23: TADM tolerance bands for an aspiration step

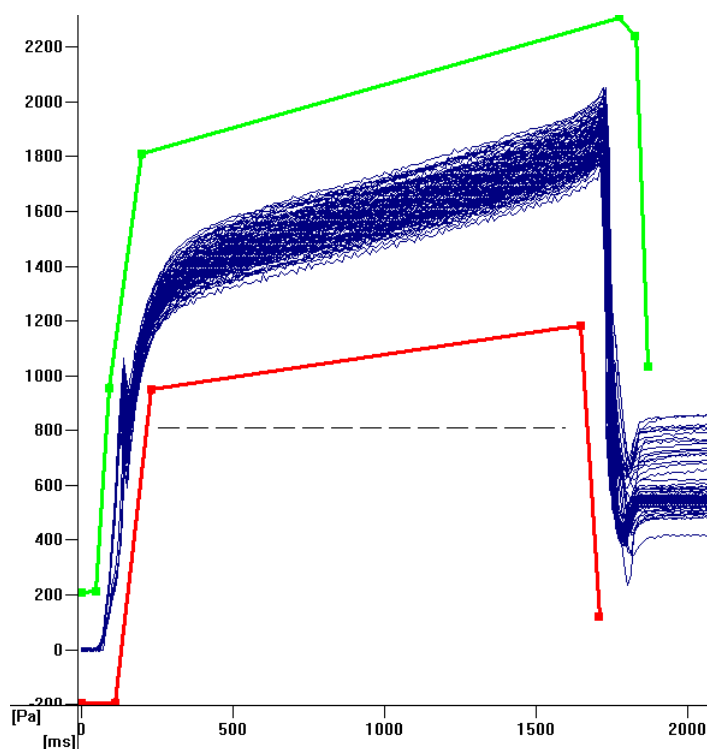
## TADM Programmer's Guide

- Make sure that the upper TADM tolerance band dips below the broken line shown in Figure 23. This line represents the pressure in the channel at the end of the aspiration step.
- Choose *Add Lower Limit Curve Points* from the *Edit* menu or click on the  icon
- Follow the same rules as mentioned above for setting the lower tolerance band.

A point of the tolerance band can also be deleted  or moved  after it has been placed. Zooming in also helps in fine-tuning the placement of the points.

- Choose *Close & apply changes* under the File menu to save the TADM tolerance bands.

In the Liquid Editor's dialog box "Edit Liquid Class", the status of the selected pipetting step is now displayed as "Band saved". Changing an already defined TADM tolerance band will change the status to "Band modified".



**Fig. 24: TADM tolerance bands for a dispense step**

- The same criteria can be used for applying TADM tolerance bands for dispensing steps (Figure 24), but make sure that the lower TADM tolerance band rises above the broken line. This line represents the pressure in the channel at the end of the dispense step.
- These steps have to be repeated for all liquid classes and volumes used in the method that require TADM.
- After the TADM tolerance bands for all pipetting steps required are defined, press OK and close the liquid editor.

## 4.6.2 Defining the TADM Tolerance Band for Dispense on the Fly

A special pipetting mode is used in the function *DispenseOnTheFly*. This step does perform a serial dispense of part volumes without stopping the movement in the X-direction.

From this pipetting mode, a different pressure curve results. Please see below the 12 peaks in the dispense curve, representing the on-the-fly-pipetting of 50ul per well with one channel over the row A (A1 – A12) in a 96 well plate.

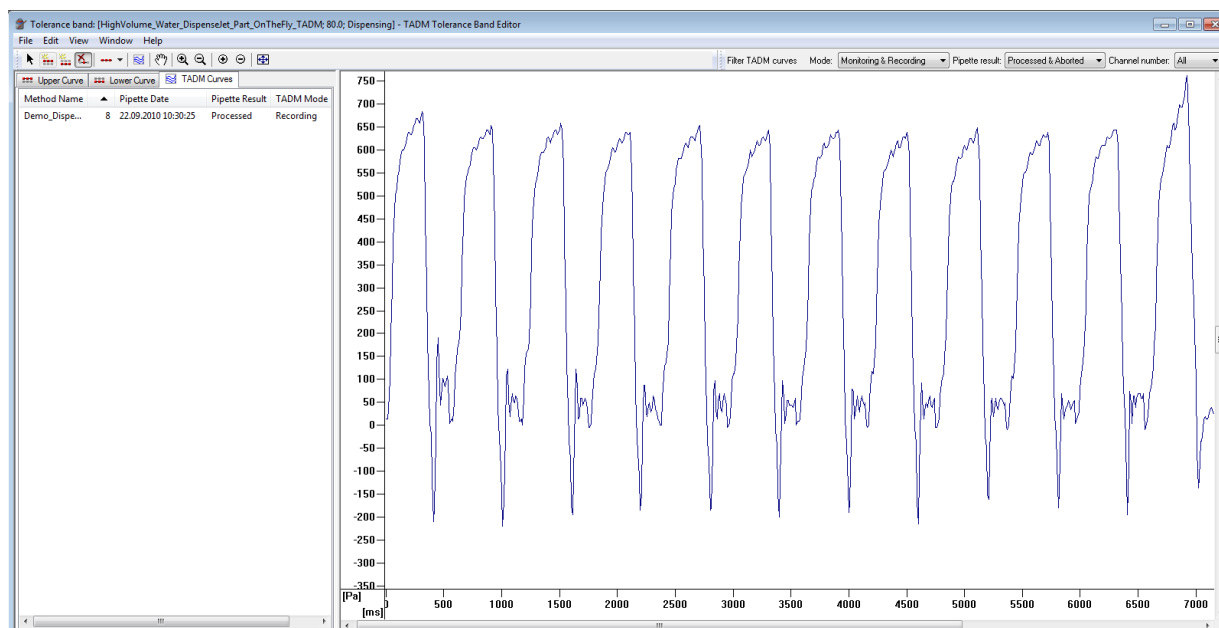


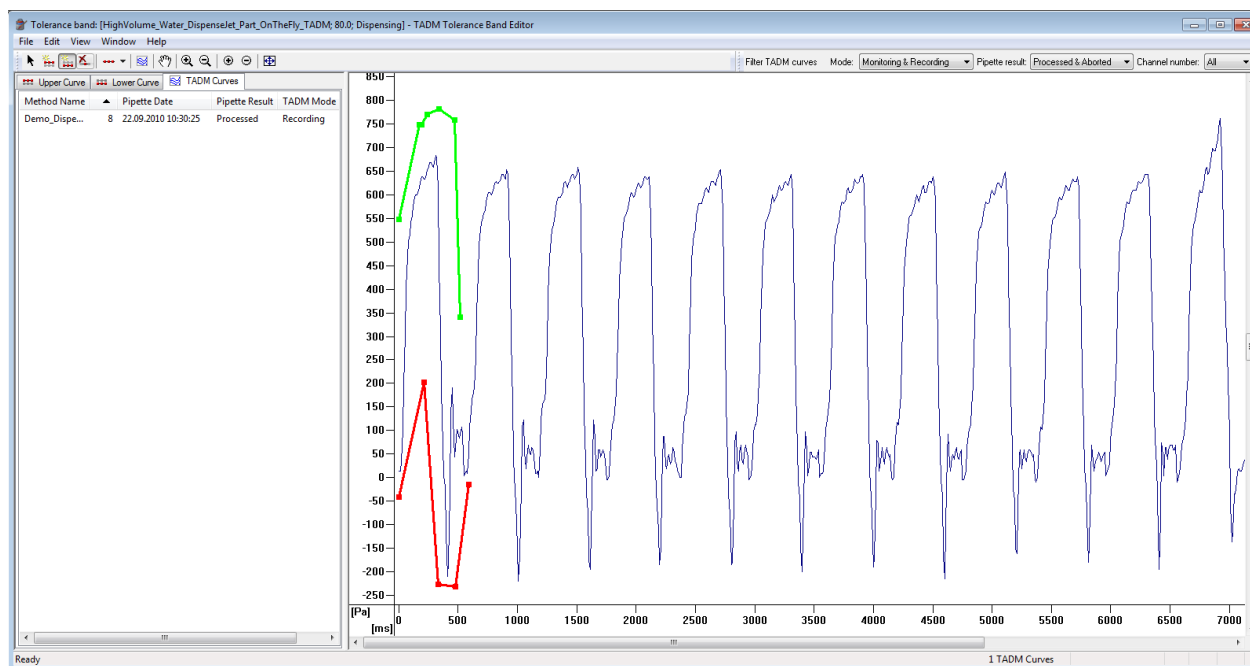
Fig. 25: Pressure curve for a dispense on the fly step

# TADM Programmer's Guide



## NOTE

*It is not necessary to define a tolerance band over all peaks of a dispense-on-the-fly pressure curve. Simply define the upper and lower limitation curve for the first peak, all following peaks will be handled respecting the data defined for peak one.*



**Fig. 26: Tolerance band for a dispense on the fly step**

# TADM Programmer's Guide



## NOTE

Please make sure the defined upper and lower limitation curve respects the highest peak and the lowest source in the whole curve, although it is defined only for the first peak.

Refer to Figure 27, where the highest peak is at the end of the 12 shots.

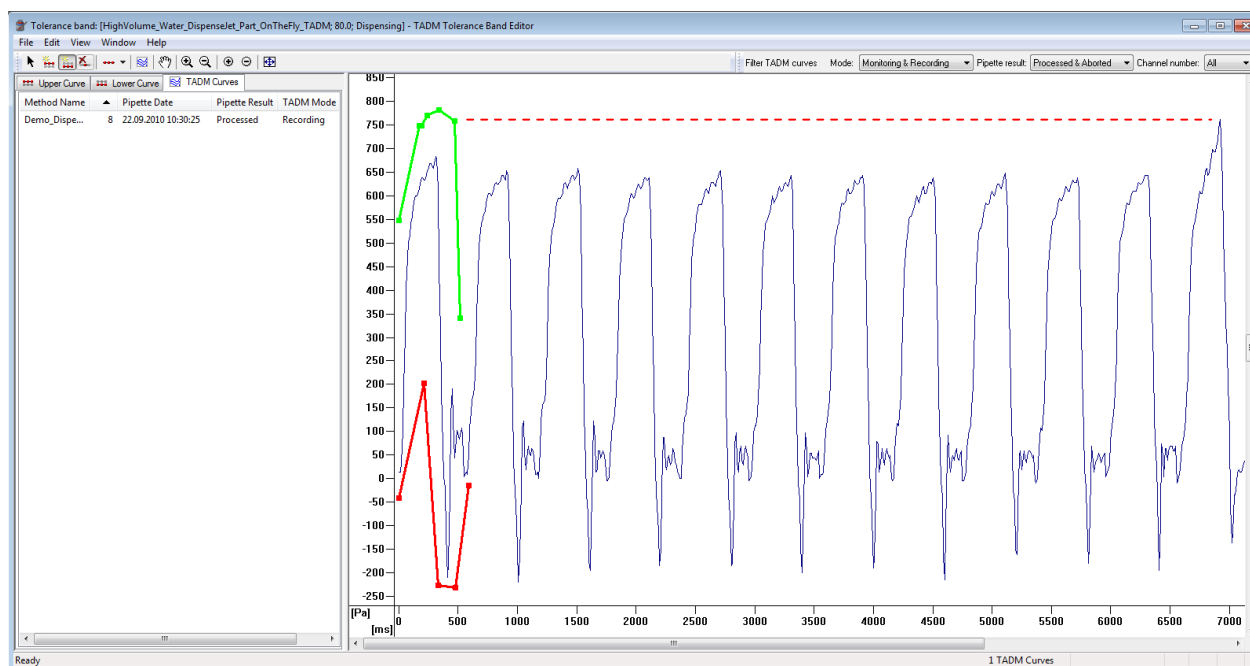


Fig. 27: Respect the highest/lowest pressure point for the tolerance band

## 4.6.3 General rules for defining the TADM Tolerance Band

### Distance between pressure curve and upper/lower limitation curve

Take care not to set the TADM tolerance bands too close to the actual TADM curves as seen in Figure 28. While this ensures a safe pipetting process, many TADM errors will occur during pipetting that will result in an unrobust process. This is due to minor variations in the sample liquid (e.g. serum) and the resulting widening of the TADM curve bundle as more and more samples are pipetted (See Figure 29).

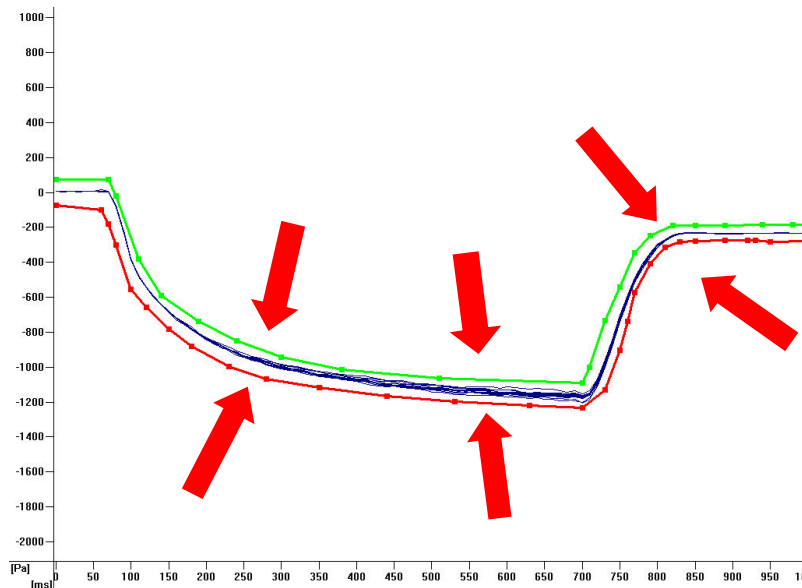


Fig. 28: Inadequate TADM tolerance bands: Bands are set too narrow

### End position of the upper/lower limitation curve

The TADM tolerance bands should stop as soon as the pipetting step ends and must not extend further than the actual TADM curves (as seen in Fig 27).

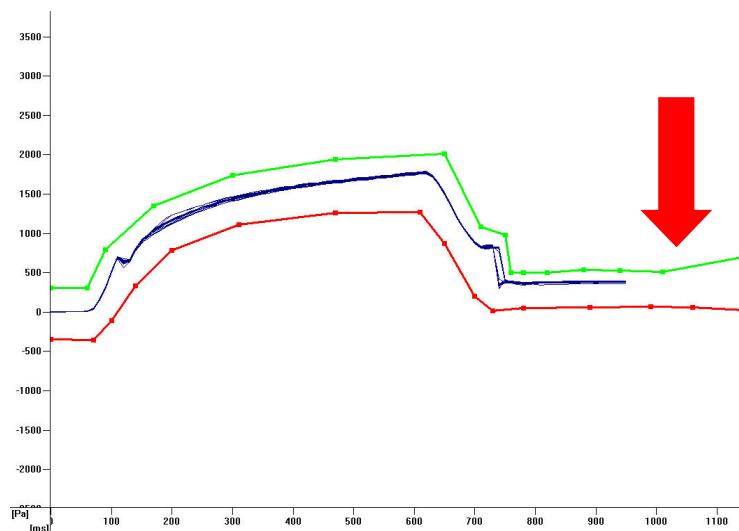


Fig. 29: Inadequate TADM tolerance bands: Bands are much longer than curve

## 4.7 Interpreting the TADM pressure curves

In order to check the usefulness of the TADM tolerance bands, perform a run using stressed samples (clots, foam, etc.) in TADM monitoring mode (Figure 30).

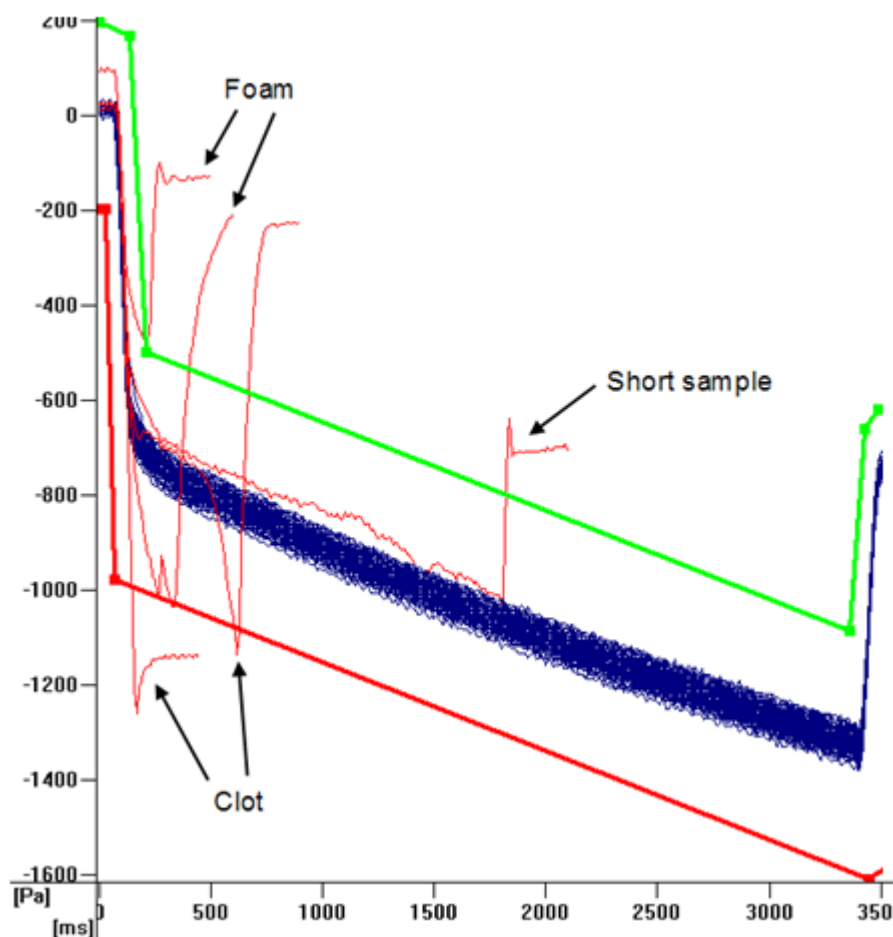


Fig. 30: TADM curves obtained from a run using stressed samples

## 4.8 Working with TADM

In order to enable TADM, the setting has to be changed within the system configuration editor (Figure 10). Choose between "None", "Error curves only" and "All curves" for the "TADM Upload Mode". In either case TADM will be enabled and each pipetting step will be monitored.



## 5 The TADM Tolerance Band Editor

### 5.1 Overview

The TADM Tolerance Band Editor consists of several parts, as shown in its main window.

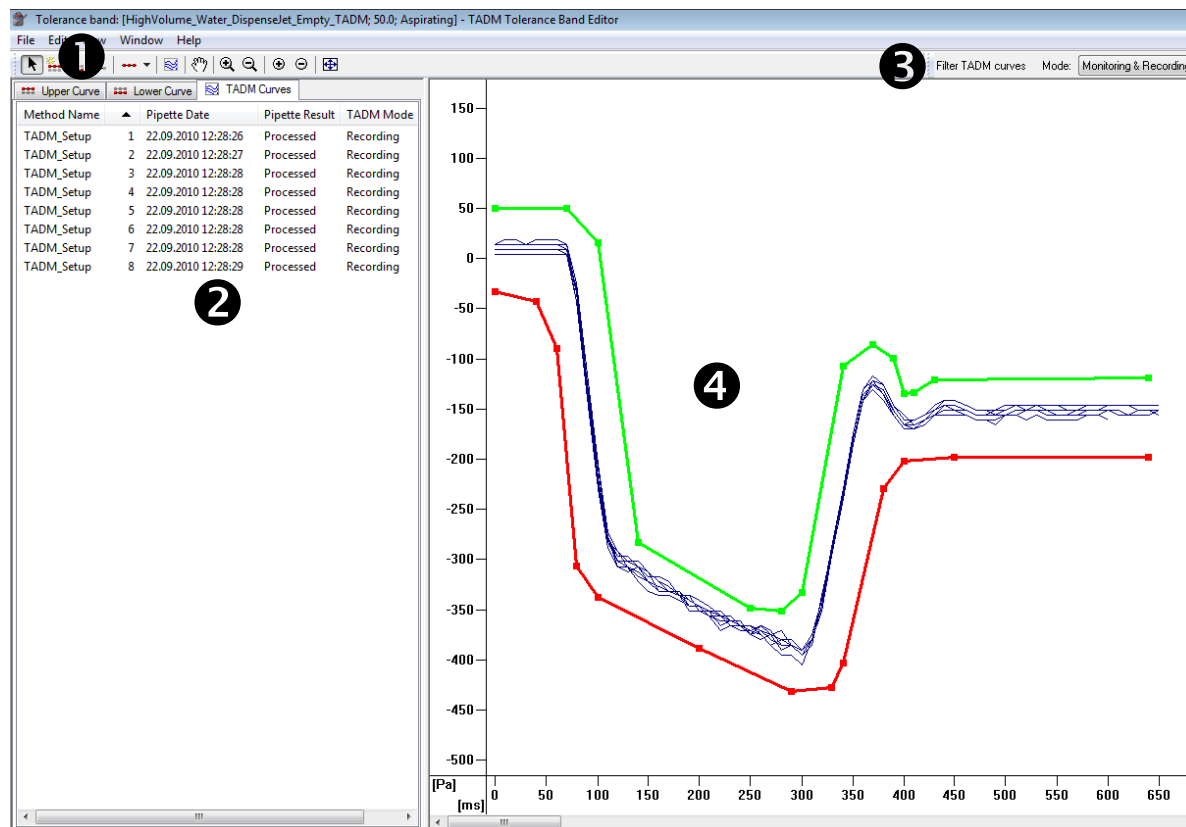


Fig. 31: TADM Tolerance Band Editor main window

- 1 Menu toolbar
- 2 TADM window
- 3 Filter TADM Curves toolbar
- 4 Plotting area

The TADM window consists of three tabs (Upper Curve, Lower Curve, TADM Curves). The first two tabs contain the coordinates for the points of the upper and lower tolerance bands respectively. The third tab lists the properties of the displayed TADM curves. The following properties can be viewed: the method name of the run where the TADM curve was recorded, the channel number, pipette date, pipette result (processed/aborted), TADM mode (Recording/Monitoring), and the Curve ID. TADM curves of aborted pipetting steps are displayed in red in the plotting area, while successfully processed ones are displayed in dark blue.



#### NOTE

The Pipette result "Aborted" can only occur if the run was performed in Monitoring mode.

# TADM Programmer's Guide

Analyzing a large number of TADM curves in an efficient way can be achieved by using the functions available in the "Filter TADM curves" toolbar:

- choose between curves obtained during either recording mode, monitoring mode or both.
- choose between processed, aborted, or all curves obtained
- choose whether curves from all channels or just a specific channel should be displayed.





Obviously, it makes sense to combine these options to limit the number of curves that have to be analyzed – for example: display all curves that were aborted (in monitoring mode) using channel number 5.

## **5.2 Menu details**









Below is an overview of all available menus with their options and the corresponding toolbar icons:

File	Description
Close & Apply Changes	Changes made to the tolerance band (upper and lower limit curves) will be saved and the Tolerance Band Editor will be closed.
Close & Cancel Changes	Tolerance band changes will be ignored and the Tolerance Band Editor will be closed. If any changes were made, a cue appears to discard all changes.

## TADM Programmer's Guide

Edit		Description
Cut	Ctrl+X	These options apply to individual tolerance band points, and are only active when either the "Upper curve" or "Lower curve" tab is selected.
Copy	Ctrl+C	
Paste	Ctrl+V	
Delete	Del	
Select		When activated, tolerance band points or TADM curves are selectable by clicking on them in the plotting area
Add Upper Limit Curve Points		When activated, clicking in the plotting area adds an upper/lower tolerance band point
Add Lower Limit Curve Points		
Delete Limit Curve Points		When this is activated, clicking on a tolerance band point deletes it
Delete Limit Curve Point	Del	Deletes a single selected tolerance band point
Exclude TADM Curve	Ctrl+E	A selected TADM curve will be excluded (not shown, and not used for guidance curves).

## TADM Programmer's Guide

View	Description
Hand Tool <span style="float: right;">Ctrl+H </span>	Move plotting area.
Zoom In Tool <span style="float: right;">Ctrl+Shift+I </span>	Zoom into or out of plotting area as desired.
Zoom Out Tool <span style="float: right;">Ctrl+Shift+O </span>	
Zoom In <span style="float: right;">Ctrl+I </span>	
Zoom Out <span style="float: right;">Ctrl+O </span>	
Fit To Window <span style="float: right;">Ctrl+F </span>	Fit all curves to window.
Guidance Curves	Display guidance curves.
Excluded TADM Curves	Display excluded TADM curves as dashed lines.
TADM Curves... 	Add or remove TADM curves.
Guidance Curves Formula...	Edit guidance curve parameters.
Line Size 	Change size of selected, guidance and limit curves
Refresh <span style="float: right;">F5</span>	Refresh plotting area.

Click "Help" in the dialog box of menu item "Guidance Curves Formula..." for the formula behind the guidance curves.

Window	Description
Upper Limit Curves <span style="float: right;">Ctrl+U</span>	Display upper or lower limit curve points as desired.
Lower Limit Curves <span style="float: right;">Ctrl+L</span>	
TADM Curve Properties <span style="float: right;">Ctrl+T</span>	Display TADM curve properties on left side of window.

Help	Description
Help Topics	View the online help.

## 6 Glossary

Term	Definition
<i>ADC</i>	Anti Droplet Control to prevent drops while pipetting highly volatile solvents.
<i>Adjustment</i>	Detailed positional setting for the hardware.
<i>Air displacement tip</i>	Hamilton CO-RE disposable tip
<i>Aliquot</i>	Aliquots are identical small volumes of liquid.
<i>Aspirate</i>	Procedure to draw up liquid into a pipetting device.
<i>Autoload</i>	Hardware assembly that enables automatic loading of the ML STAR. It consists of a loading head movable in Y direction, which draws the carriers into the MICROLAB® STAR and can read the barcodes on them.
<i>AutoLoad tray</i>	Hardware unit. The carriers can be placed on it and held outside the ML STAR. The loading tray is attached to the ML STAR, to support the automatic loading and unloading process.
<i>Barcode Mask</i>	The barcode mask defines the basic structure of a barcode. It is a pattern to which a barcode must conform. The assignment of a specific Labware item can be done in this manner. The barcode mask can require a barcode to contain specific strings at fixed positions. It can also contain wildcards.
<i>Barcode Reader</i>	Device for reading sample/plate Barcodes. Part of the Autoload Option.
<i>Carrier</i>	Unit for loading plates, tubes and tips on the ML STAR Line deck. Loading process is carried out by the autoload unit.
<i>Container</i>	A container defines a tube, vessel or a single well of a plate.
<i>Container identification</i>	Barcode for the identification of a container. Servers for a unique identification of a vessel, e.g. a sample test tube.
<i>Deck</i>	The work surface of the ML STAR. It presents at the same time the greatest possible area, cf. <i>Work Area</i> . The deck is divided into tracks. Carrier placement is defined by the tracks, as long as they are in the operating range of the pipetting area.
<i>Deck Layout</i>	A collection of labware placed upon a deck.
<i>Dispense</i>	To distribute quantities of liquid from a pipetting device.

## TADM Programmer's Guide

Term	Definition
<i>Docking station</i>	The long bar at the back of the ML STAR instrument for guiding the cables and the tubing for accessories.
<i>Firmware</i>	Lower Level program code that is carried out on the processors of the ML STAR Instrument
<i>Front Cover</i>	Protective covering for the ML STAR Instrument, featuring a hinged front window made of transparent Plexiglas. With this option and assembly, the work surface of the ML STAR is covered in such a way that it is shielded from user intervention and other outside influences (such as dust). At the same time, it protects the user from the movements of the ML STAR.
<i>Hardware Error</i>	Type of error that is caused by a technical problem with the hardware
<i>HSL</i>	Hamilton Standard Language
<i>HHS</i>	Hamilton Heater Shaker. Unit to heat or shake microplates in SBS format.
<i>HSB</i>	Heater Shaker Box. Interface unit which is needed if more than two HHS are being used.
<i>Instrument</i>	Hardware of the ML STAR (mechanics, electronics, and firmware)
<i>Instrument steps</i>	The commands made available by the firmware for controlling the ML STAR.
<i>Labware</i>	Refers to movable items to be placed on the ML STAR deck, such as carriers, containers, or racks.
<i>LIMS</i>	Higher level data processing system, generally known as Laboratory Information Management System, also LMS.
<i>Liquid</i>	Includes all kinds of liquids, among which are included reagents, controls, standards, wash fluids.
<i>LLD (Liquid Level Detection)</i>	Detection of liquid surface which may be achieved either by pressure or capacitive signal detection.
<i>Loading/unloading</i>	The process by which plate, tube and tip carriers are brought on and off the ML STAR deck. This is automatically performed via autoloader unit.
<i>MAD (Monitored Air Displacement)</i>	Aspiration monitoring Feature. During the aspiration process, the pressure within the pipetting channel is measured in real time.
<i>Method</i>	The method contains all instruction that must be executed during a run.
<i>ML STAR Software</i>	Software to run the ML STAR.

## TADM Programmer's Guide

Term	Definition
<i>MTP (Microtiter plate)</i>	In general, a microtiter plate is assumed to have 96 wells (8 x 12) 9mm wide. There are also plates with 384 wells (16 x 24 / 4.5 mm), or others with a different size
<i>Pause</i>	Interruption of processing. The current processing steps are completed.
<i>Pipetting</i>	Transfer of liquids from one container to another.
<i>Pipetting arm</i>	Assembly equipped with the pipetting device and/or plate handler.
<i>Pipetting channel</i>	Hardware including the function of picking up a tip aspirating, dispensing, tip eject, liquid level detection and the Y/Z-movements
<i>Pooling</i>	Pipetting of different liquids in one well; 1, 2, 3...to n and n to 1, 2, 3...
<i>Processing Step</i>	Defines what must be carried out on the ML STAR instrument, as well as the location it must be carried out and possible interaction with other system components or labware. The action is defined in accordance with the methods, the loading and the tasks.
<i>Rack</i>	Group of containers, as DWP, MTP, etc.
<i>Rack identification</i>	Barcode for rack identification
<i>Random access</i>	Means that every channel can access any position anywhere on the work area.
<i>Run</i>	Execution of the processing steps defined in the method with the aim of processing one or more liquids and containers (e.g. MTP). The run is a series of timed commands, in order to carry out processing on the ML STAR according to the processing plan.
<i>Run abort</i>	Cancelled run by the user or by the ML STAR
<i>Run visualization</i>	Visualization of the current run, reporting the status of the ML STAR.
<i>Sample</i>	Refers to a liquid in a unique identified container which is to be processed.
<i>Stacker</i>	Storage unit for racks
<i>Side Touch</i>	Pipetting on the wall of a container of it's center to prevent droplets.
<i>TADM</i>	Total Aspiration and dispense monitoring. The pressure inside each individual pipetting channel is monitored, during aspiration and dispensing.
<i>Tip</i>	Disposable tip for pipetting
<i>Tip rack</i>	Frame that holds the tips.

## TADM Programmer's Guide

<b>Term</b>	<b>Definition</b>
<i>Tip waste</i>	Container for ejected tips.
<i>Touch-off</i>	Type of dispensing where the tip approaches the bottom of the empty container so close as to allow the dispensed droplet to have simultaneous contact with the tip and the container bottom.
<i>Trace</i>	Record of the status during processing
<i>Tube</i>	A container for liquid, usually having a circular cross-section, and a cylindrical length section.
<i>User</i>	User of the software. Access rights for different types of users can be defined, such as operators, laboratory manager, etc.
<i>Waste Container</i>	A device on the ML STAR deck to collect used disposable tips.
<i>Well</i>	The individual container of a MTP or DWP.
<i>Well type</i>	Geometrical shape of the well, such as U, V or flat.
<i>Wick side of container</i>	Type of dispensing where tip touches the side of the container and thus releases the droplet. This function is not available for the ML STAR instruments.
<i>Work area</i>	The area of the ML STAR to which access is provided during the processing. Elements to be pipetted or handled can be placed in this area.
<i>Worklist</i>	Information according to which a method is to be executed on the ML STAR. A worklist may contain different parameters e.g. Pipetting volume, heating temperature, shaking speed, etc.