

# Training Guide Electrodes



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# **Document Structure and General Principle**

## Synoptic

The principle is to generate an electrodes document using the core/cavity block's part document in which you can model the shape of the electrodes based on the faces of the shape to be burnt. Each resulting electrode will be a part document.



## Reference system of electrodes

By convention, we will use the **Z**- axis of the electrodes document's absolute frame as the plunge direction of electrodes.



# **Exercise 1: Creating an Electrode Using the Wizard**

# Importing the package

• From the **Home** tab, **P** import the project named *TopSolid-Electrode Training.TopPkg*.

#### Preparing the core block

• Open the part document named *Core Block*.

### Creating the frame origin for electrode positioning

- From the **Construction** tab, create a **constrained frame**. Select the part's parting surface as the **support plane**.
- Select the right face as the **first plane** and the left face as the **second plane** for the **first constraint** as shown below.
- Select the front face as the **first plane** and the back face as the **second plane** for the **second constraint** as shown below.
- For the **orientation**, select a block edge as shown below.



• Right-click on the frame that you have just created and select the **Others** > **b Publish Frame** command.

• Rename the publishing as shown below.

			-	
L	Sketch			
	Selection			
-6	Show Only			
65	View Horizontally			
	Others	•	~	Publish Axis
	Frame on Plane (Frame 1)		-	Publish Direction
2	Edit		3	Publish Frame
	Replace	•		
	Others	•		
	Frame 1			
66	Hide			
<b>(?)</b>	Attributes			
×	Delete			
	Styles	•		
٩k	View from Top			
	0.1			

<b>∽× × ?</b>
Publish Frame
Name:
F1
Description:
Block Frame
Frame:
🖊 Frame 1 🗸 🕈

Save the document.

#### Including the core block in a new electrodes document

**<u>Note</u>**: There are many ways to include a part in an electrodes document:

- Right-click on the part document's tab and select the **U** Electrodes command.
  - Right-click on the part document in the Project tree and select the 🥊 Electrodes command.
- Create a new document by selecting an electrodes document, and then drag and drop the part document into the electrodes document from the Project tree.
- From the Project tree, right-click on the *Core Block* part document and select the **V** Electrodes command.
- Select **Blank Template** and click on  $\checkmark$  to **confirm** the operation.

## Positioning

• Right-click on the part in the graphics area and select the 🍣 Edit Positioning command.

A **Frame on Frame** constraint has been created. **TopSolid** automatically positions the published frame on the absolute frame, which often saves you time when it relates to positioning.



<u>Warning</u>: If more than one frame has been published, the **Frame on Frame** positioning constraint is not created and is replaced by a fixed constraint.

#### Removing the drillings

Removing the drillings makes it easier to create electrodes when there is, for example, an ejector in the area to be eroded.

• From the Electrode tab, select the **Drillings Detection** command.



- Click on the Next icon. The Removing Cooling Circuits and Drillings command launches automatically.
- Select **Cap** as the heal type.

🗙 🗶 🖡 🥶 ?	
Removing Cooling Circuits and Drilli	ngs
Shape to burn:	
Shape To Burn (Core Block <138>)	~
Heal type:	
Сар	$\sim$
Display removed drillings.	

• Click on 💙 to **confirm** the operation.

Warning: This command is only available in the preparation stage.

## Selecting the origins

We are going to define the different frames of the electrode:

- Machining frame
- Machining positioning frame
- EDM frame





Machining frame

EDM frame TopSolid

- From the Electrode tab's drop-down menu, select the *Felectrodes Frames* command.
- Select Base bottom frame as the machining frame, machining positioning frame and EDM frame.



Click on <sup>V</sup> to confirm the operation.

<u>Note</u>: The EDM frame corresponds to the electrode's frame and will later be used to dimension the positions of the electrodes in the drafting document. It can also be used as a reference for the coordinates of control points.

#### Creating an electrode using the wizard

The creation of an electrode is done in three steps:

- Creating the shells (area to be eroded)
- Creating the **eroding shape**
- Creating the electrode
- Select the 🕺 Electrode Wizard command. The 🤛 Shells command launches automatically.
- Select the **Faces** mode, and then use the rotary picking technique to select all the pocket's faces as shown below.



The 🥊 Eroding Shape command launches automatically.

• Adjust the following settings.

🖌 🗙 🧍	?		
Eroding S	hape		
Shell:			
Shell 3		~ 🔶	
Direction:			-
Frame (Shap	pes To Burn Set 1	:Z Axis 🗸 🔶	
First exter	nsion		
Limit:			
Length		~	
15mm			-
T			
TA TA			
Follow draft			
	tancion		
Secondrex	ttension		
Limit:			
Length		~	
6mm		~ *	
Draft angle:			
[ <sup>b</sup>			
$\bigcirc$			
$\geq$			
Spark gap			
<ul> <li>Theoretical</li> </ul>			
O Applied			
	Name	Spark gap	
	Rough	0,8mm	
	Semi-finish	0,3mm	

<u>Note</u>: If the spark gap is applied, the faces of the eroding shape are offset by the spark gap value. However, if the spark gap is theoretical, the faces are not offset, but the information is retrieved in the machining.

• Click on 💙 to **confirm** the operation.

- The **Flectrode** command starts automatically.
- Adjust the following settings.



• Click on 💙 to **confirm** the operation.

A part document for the electrode is then created in the Project tree, within the electrodes document.



<u>Note 1</u>: The base dimensions are calculated automatically based on the margin defined in the **Electrodes** section of the Electrodes document's Options tree.





**Note 2**: If you open the part document of the electrode and you switch to **Analysis Stage**, you can find the machining and EDM frames.



**Note 3**: The icon bar at the bottom right of the graphics area lets you easily hide or show the main elements of the document.





# **Exercise 2: Electrode and Shell by Face Selection**



## Creating the shell

- Select the 💆 Shells command.
- Select the following inner faces of the pocket framed in red in the above image as shown below by using the rotary picking technique if necessary.



- Click on 💙 to **confirm** the operation.
- Click on the **Hide/Show Shapes to Erode** icon to hide the block.

• From the **Surface** tab, create two **V Iofted** surfaces based on the shell edges.



- **Sew** these two surfaces to the shell.
- **C** Extend the surface to *1mm* as shown below.



## Creating the eroding shape

- Select the 📕 Eroding Shape command and adjust the following settings.

Shell:			
Shell 2		~	
Direction:			
Prame (S	Shapes To Burn Set	1):Z Axis 🗸 🕂	
First ov	tancion		
<b>Hirst ex</b>	tension		
Limit:			
Length		~	
20mm			
IP II			
	ft		
Follow dra			
	-		
	јар		
Polici dra	jap		
	jap		
<ul> <li>Polici dra</li> <li>Spark g</li> <li>Theoretica</li> <li>Applied</li> </ul>	jap I Name	Spark gap	
<ul> <li>Pollow dra</li> <li>Spark g</li> <li>Theoretica</li> <li>Applied</li> </ul>	jap I Name Rough	Spark gap 0,8mm	
Polici dra Polici dra Spark g Spark g Polici dra Polici dra Polici dra Polici dra Polici dra Spark g Polici dra Polici dra Spark g Polici dra S	Jap I Name Rough Semi-finish	Spark gap 0,8mm 0,3mm	

Click on  $\checkmark$  to **confirm** the operation. •

In order to guarantee the sharp angles on the eroded shape and to facilitate the realization of the electrode, we are going to break down this electrode into two parts.

## Creating a second eroding shape using the Shape mode

- From the **Shape** tab, <- trim the eroding shape with a plane.
- Check the Keep trimmed side box in the Advanced Options dialog box.

<mark>∕ × ∞ ⊗} ?</mark>	
Trim	
Shape to modify:	
Eroding Shape 2 - Theoreti 🗸	
🥪 🧳 💭 📖 👘	
Trimming plane:	
Eroding Shape 2 - The 🗸 💠	
Reverse	-
<b>7</b> 5	
Advanced Options	
Hide tools	
Keep trimmed side	
Fill representations	

- Click on 💙 to **confirm** the operation.
- From the **Shapes** folder in the Entities tree, hide the **eroding shape 2**.
- On the trimmed side, perform a **v** face modification operation in order to offset the following face by *1mm*.

Faces Modification	
aces:	
Face(Shape 3:Face(1341) 🐥	
hift:	
mm	

• Select the 🏴 Eroding Shape command, select the 🏼 🔽 Shape mode, and then adjust the following settings.



• Click on 💙 to **confirm** the operation.

# Creating the electrode

• Select the **F** Electrode command and select eroding shape 2.

Electrode 2 Froding shapes: Froding Shape 2 - Theoretical Hide Base Origin frame: Frame (Shapes To Buy $\oplus$ Centered	20
iroding shapes:         Eroding Shape 2 - Theoretical         Hide         Base         Origin frame:         Frame (Shapes To Buy the state of	20
Eroding Shape 2 - Theoretical Hide Base Origin frame: Frame (Shapes To Buy $\clubsuit$	17 - T
☐ Hide Base Origin frame: Frame (Shapes To Bu> ♥ ☐ Centered	17 - T
Origin frame: Frame (Shapes To Buy $rain rain rain rain rain rain rain rain $	17
Origin frame: Frame (Shapes To Buy	17-
Frame (Shapes To Buy 🕂	
Centered	
-	1 12
X position:	
85mm	
Y position:	
68mm	
Definition       The second secon	
🔊 Basic direction 🗸 🕂	
X length:	
17mm	and the second sec
Y length:	
12mm	
Z length:	

• Click on 💙 to **confirm** the operation.

**<u>Note</u>**: Once the electrode has been created, it appears in the **Parts** folder in the Entities tree.

Exercise 2: Electrode and Shell by Face Selection

• Repeat the procedure for **eroding shape 3**.



- Click on 💙 to **confirm** the operation.
- **Bave** the document.

# **Exercise 3: Multiple Electrodes and Shell by Edge Selection**





## Creating the shell

• Select the 😈 Shells command using the 💝 Edges mode. Select the following edges.



To complete the loop, we will create the last segment.

Click on the <sup>+</sup> icon and select the <sup>(1)</sup> Imprint command.



# • Select the **W** By two points mode.

✓ × ∞1 ?	
	1
Shape to modify:	
Shape To Erode 1 (Shapes To Burn S $ \smallsetminus $	
10 10 10 10	
Start point:	
Shape To Erode 1 (Shapes To Bi 🗸 🕂	
End point:	
Shape To Erode 1 (Shapes To Bi 🗸 💠	
Direction	
Orthogonal	
○ Specified	
Faces	
Advanced Options	
Advanced Options	
Hidden faces:	
Shape ~	
Connection of imprinted edges:	
None 🗸	
Imprint precision:	
Auto ~	
✓ Include in selection	

Click on to confirm the imprint and the shell.

# Creating the eroding shape

• Select the **Froding Shape** command and select the previously created shell.

V.			
Shell:			
Shell 3	~ 🕈		
Direction:			
	~ 🕂		
Limit:			$\langle \rangle$
Length	$\sim$		
20mm		/	
I9 II			77
Follow draft			
Second extension			
Limit:			
Length	$\sim$		
бтт			
Draft:			
5°			



• Click on 💙 to **confirm** the operation.

• From the **Shape** tab, perform a **v** face modification operation to offset the electrode from the part by *3mm*.



• Click on 💙 to **confirm** the operation.

#### **Creating electrodes**

Select the Pattern Union command and adjust the following settings.



• To define the axis of rotation, select the **midpoint** of the electrode as the **start point** and the **Absolute Z Axis** as the **direction**.



Click on to confirm the pattern and the pattern union.



#### Creating the electrode

Select the Following settings.



• Click on 💙 to **confirm** the operation.

Warning: The base must be centered on the axis of rotation selected during the Pattern union operation.

### Adding fillets on the base

• Right-click on **electrode 4** and select the Kin Place Edit command as shown below.



• Right-click on one of the vertical edge of the electrode and select the 🍣 Fillet command.



• **Save** the document.

•

# **Exercise 4: Markers, Control Points and Properties**

# **Orientation markers**

•

Select the **Orientation Marker** command. Select **electrode 4** and adjust the following settings.

Electrode to mark:		
Electrode4 <275>	~	
- Frame Positioning frame:		
Base <277> (Publishings)	~ 🕈	
Angle of rotation along Z axis: 0°		
Template document:		
🚏 Partial Chamfer	~	
Code:		
	~	
		4
5mm Second Distance: 5mm Depth: 4mm		 - <u>e o</u> ,
5mm Second Distance: 5mm Depth: 4mm Corner Type:		 - <u>* °</u>
5mm     Second Distance:     5mm     Depth:     4mm     Corner Type:     x+ y+		 - <mark>~ 0°</mark>
5mm     Second Distance:     5mm     Depth:     4mm     Corner Type:     x+ y+		 - <u>~ 0°</u>
5mm Second Distance: 5mm Depth: 4mm Corner Type: x+ y+ Advanced Options		- <u>e o</u> ,
5mm Second Distance: 5mm Depth: 4mm Corner Type: x+ y+ Advanced Options Representations		
5mm         Second Distance:         5mm         Depth:         4mm         Corner Type:         x+ y+         Advanced Options         Representations         ③ All		

- Click on  $\checkmark$  to **confirm** the operation. •
- Repeat the operation for the other electrodes.
- **Save** the document.

#### **Control points**

The **Control Point** command allows you to create a significant point on the electrode. This point will be projected in the electrode drafting document and can be dimensioned according to the gap applied to the electrode via the **Control Point** command in the drafting document.

<u>Note</u>: The control point is added to the detailed representation of the electrode part. Therefore, by default it will be visible in the detailed drawing of the electrode part. However, in the global drawing of the electrodes document, it will not be visible. However, it is possible to add these points manually in the detailed representation of the electrodes document.

• Select the 😺 Control Points command. Select the bottom face of the first electrode.

Control Point	
Origin: EDM frame ~ Point:	
Electrode <276>:Face(873) Create normal	

- Click on 💙 to **confirm** the operation.
- Position the control points on the other electrodes.

<u>Note</u>: In the **Origin** field, if the **EDM frame** is selected, the reference for the coordinates of the control point is the absolute frame of the electrodes document.

#### **Electrode properties**

• Select the Electrode Properties command. Select the first electrode and enter the following properties.

<b>⊻ × </b>
Electrode Properties
Electrode:
Electrode4 <275>
Main Properties
Machine name
Rough
Magazine pot number
Finish mode
Unspecified
Semi-finish
Magazine pot number
Finish mode
Unspecified
Finish
Magazine pot number
2
Finish mode
Glossy Satin Finished Surface

<u>Note</u>: The electrode properties can be retrieved in a bill of material and a drafting document. As with standard properties, you can create user properties. These properties come from the **TopSolid Electrode** library which must be referenced.

- Repeat the same operation on the other electrodes if necessary.
- Click on 💙 to **confirm** the operation.
- **Bave** the document.

# **Exercise 5: Theoretical Positions**

# Repeating an electrode

• Create the following 🗠 frame on plane.



• Create similar frames on the other grooves. Make sure you invert the X axis on the opposite grooves.



• **F** Repeat electrode 4 using a **Pattern on frames**. The reference frame is the frame corresponding to the position of the first electrode.



• Click on 💙 to **confirm** the pattern and the repetition.



• 月 Save the document.

All the electrodes were machined in the same area. We will therefore impose rotations on them.

• In the **Construction** tab, select the **Construction** command.





• For the rotation axis, select Axis by Point and Direction.



• For the start point, select the midpoint as shown below and the Absolute Z direction.

✓ × ?			
Axis by Point and	Dir	-	
Start point:			
~	÷	*	
Direction:	*	Creation Barycenter Point	
Absolute Z Axis	3	Cartesian Point	
	4	Center of Mass Point	
	*	Constrained Point	
	Å,	Extreme Point	
	×	Intersection Point	
	.* *	Midpoint	
	14" 	Point on Profile	
		Point on Surface	
	٠	Point	
	<u>}</u>	Projected Point	
	ङ	Spherical Point	
		1	
Midpoint			
First point:			
Electrode <429>:Verte: 🗸 🕂			
Second point:			
Electrode <429>:Verte: > 🕂			

- Click on 💙 to **confirm** the transformation.
- Repeat the same operation on the other electrodes if necessary.

# **Exercise 6: Electrode Bridge**

# Creating the shell

• Select the **Shells** command using the **Faces** mode. Select the faces of the first pocket using the rotary picking technique.



- Click on 💙 to **confirm** the operation.
- Create a 📥 plane by point and normal.

Drigin:			
Shell 4:Vertex(212)	~ 🕂		
lormal:			
Shell 4:Edge(158)	~ 🕈		
Automatic direction		J T	
) Horizontal direction (X):			
) Vertical direction (Y):			
7			

• Click on 💙 to **confirm** the operation.

• Trim the shell using the plane you have just created.



• Click on 💙 to **confirm** the operation.

# Creating the eroding shape

• Select the 💛 Eroding shape command.

🖌 🗶 🗍 ;	
Eroding Shape	
V.	
Shell:	
Shell 4 🗸	
Direction:	
🖊 Frame (Shapes To Burn Set 1) 🗸 🕂	
First extension	
Length ~	
30mm	
19 19	
Follow draft	
<b></b>	
C	
<b>9</b>	

• Click on 💙 to **confirm** the operation.

• Shift the following face by *5mm* using the **Faces Modification** command.



#### Repeating the eroding shape

Repeat the eroding shape using a ising a linear pattern in is Line by two points mode.



- Click on  $\checkmark$  to **confirm** the pattern, and then the repetition.
- Repeat the operation using a **iiii linear pattern** and by selecting the following points as **start** and **end** points.


### Creating the electrode

Select the 🥊 Electrode command and create the following electrode by selecting the three eroding shapes.





<u>Note</u>: If a predefined manufacturer's stock is used and the **Base defined by stock** box is checked, the dimensions of the selected stock are taken into account for the base.

- Click on 💙 to **confirm** the operation.
- 😼 Save the document.

# **Exercise 7: Wire Electrode**

### Creating the shell

• Switch to **Electrodes Stage**.



• Create a **ketch** on the highlighted plane as shown below.



• Create the following two **arcs** as shown below.



• **(Upprint** the previously created sketch on the shape to erode.



Create the following shell using the Faces mode. Draw a selection box from left to right as shown below.



• Select the 🕏 **Pipe** command and create the following two surfaces in order to fill the holes.



- Sew the two new surfaces to the shell.
- Click on 💙 to **confirm** the operation.

## Creating the eroding shape

• Create the following 📕 eroding shape using the 👂 Shell mode.



Click on to confirm the operation.

### Finishing the electrode

• Select the **Flectrode** command and adjust the following settings.





- Click on 💙 to **confirm** the operation.
- Edit the in-place part and create a *sketch* on the top plane of the base.

From the 2D Sketch tab's drop-down menu, select the Operations > Project command and project the following edges.



- Click on 💙 to **confirm** the operation.
- Right-click in the graphics area and select the UT Trim by Profile command. Create the following trimming operation.



• **B** Save the document.

# **Exercise 8: Electrode Drafting**

### Electrode, core block and theoretical positions

- Select the Electrodes Draft command.
- From the **Project Templates** folder, select the **A3 ISO Landscape Electrode** template.



- Click on 💙 to **confirm** the operation.
- Select the following options.

🗙 🛪 🕶 ?
Electrodes Draft
Multiple draftings
Electrodes:
All Electrodes
Hide
Ineoretical positions
Control points
Mandrels
Shapes to erode
Representation:
Detailed Representation $\sim$
Open after creation

• Click on 💙 to **confirm** the operation.

#### A drawing is created for each electrode.



<u>Note</u>: A drafting template must be created beforehand. The method used for creating the template is detailed at a later stage.

### **Control point notes**

- Open the drawing of electrode 4.
- From the **Electrode** tab, select the **T** Control Points command.
- Select the control point, select the **Rough** gap and place the note.

Eill of material:	Rough = $0.8$
~	X = -0 Y = -0,3
Geometry:	Z = -8,8
View Area:Control Point 1 🗸	
Gaps:	
Rough 🗸 🗸	
Style:	
Normal 🗸 🔶	
Edit	
Projection line:	
T#1	

- •
- Click on 💙 to **confirm** the operation. Repeat the operation for the semi-finish and finish gaps. •

# Additional Exercise: Drafting all the electrodes

- Select the Electrodes Draft command.
- In the Project Templates folder, select the A3 ISO Landscape All Electrodes template.
- Check the All Electrodes box and uncheck the Multiple draftings box.





<u>Note</u>: If more than one electrode is selected in the command, the **Multiple draftings** option is used to create one drafting document per electrode. If the option is unchecked, only one drawing will be created, with a global view of all the electrodes.

## **Exercise 9: Including Mandrels**

### **Component search**

- Open the electrodes document named *Core Block*.
- Click on the **Starch** icon at the top right of the screen.
- Adjust the following settings.

💏 Quick Search		×
Search:		
mandrel	<u></u>	
☑ Name		_
Part number		
Description		
Type:		
Part	~	
Where:		
Current project	~	of
Show first result in project tree		

• Click on the <sup>c</sup> icon to run the search.

The following search results are displayed.

Search Results (2)				₽ X
Grouping: Drag the columns onto this zone				
Name	<ul> <li>Description</li> </ul>	Part Number	Project	3
Mandrel - Base 16 × 16	Mandrel - Base 16 × 16		TopSolid Electrode	
Mandrel - Base 26 × 26	Mandrel - Base 26 × 26		TopSolid Electrode	

• **Close** the quick search dialog box.

#### Including the mandrel

- Drag the Mandrel Base 16 x 16 part to the graphics area.
- Select the electrode 4 as the **destination**.

The mandrel is automatically positioned on the electrode.

Source:	
Mandrel - Base 16 × 16 < 587> v	
Destination:	
Electrode 4 <265>	

• Click on 💙 to **confirm** the operation.

<u>Note</u>: To position the mandrel, a **Frame on Frame** constraint is automatically created between the **base frame** of the mandrel (position to be defined when the mandrel function is provided) and the **base frame** of the electrode (above the base).

0

-	<u>~ ·</u>		_
Frame on Frame 1			
lou	rce frame:		
78	Base Frame (500> (Mandrel)	~	4

# **Exercise 10: Creating electrodes on several parts**

### Preparing the cavity block

- Open the part document named *P1.Cavity block*.
- Create the origin frame for electrode positioning as shown below.
- Publish the frame.



- **b** Save and close the document.
- Create an electrodes document using a **blank template** and name it *P1.Cavity block Electrodes*.
- Urag the *P1.Cavity block* part document into the graphics area. This automatically creates a fixity constraint for the first inclusion.
- From the Entities tree, remove the fixity constraint.
- Edit **positioning 1** and create a **Frame on frame** constraint with the published frame.

We are now going to include the Spindle part document.

• Urag the *Spindle* part document into the graphics area and **constrain** the spindle in its housing as shown below.



• Confirm the positioning.

<u>Note</u>: <u>Only</u> part documents can be included in an electrodes document. TopSolid • In the **Preparation** step, select the *I shapes to burn* command from the **Electrode** tab.

The **Shapes to burn** command allows you to create a set of shapes to be burnt from the part or parts included in the electrodes document.

- Select the spindle and the block as the **parts to burn**.
- Switch to **Electrodes stage**.
- In the **Electrode** tab, select the **Shape To Erode** command and keep the default values as shown below.

<b>⊻ × ?</b>	
Shape To Erode	
Set:	
Shapes To Burn Set 1	~
Origin frame:	
Absolute Frame	~ 🕈
۲	

The **Shape To Erode** command allows you to create a set of shapes to be eroded from the set of shapes to be burnt that were previously created in the document. The electrodes will be defined from these shapes.

- Remove the drillings if necessary.
- Select the frames using the 🌾 Electrodes Frames (machining, machining positioning and EDM) command.

#### Creating the electrode on two parts

- Launch the 🕺 Electrode Wizard command in 쭏 Edges mode.
- Select the outer edge of the shape as shown below.



• Create the electrode using a cylindrical base.

We will clear the bottom face of the cone.



- Edit the part in-place and offset the face of the shape by 1,5mm using the Faces Modification command.
- Add a *1mm* connection radius to the bottom to obtain the result as shown below.



• **Confirm** the in-place editing.

#### Creating an electrode with face removal

In the **Shells** dialog box, the **Remove faces** option allows you to remove the faces on the shape to be eroded selected to create the shell. Several types of healing are available and are identical to those of the **Delete** command.

In addition, the **Parts to erode** command allows you to create part(s) from the final state of the shapes to be eroded (i.e. possibly without drillings and cavities eroded by the electrodes).

- Select the U Shells command using the Select the following edges.
- Check the **Remove faces** box and select **Extend** as the **heal type** as shown below.

Shells Shells Shells Saces: Face(Shape To Erode 1 (Shapes To Burn Set Face(Shape To Erode 1 (Shapes To Burn Set)	
Remove faces Heal type:	
Extend ~	•

• Create a second shell by removing the faces to obtain the result as shown below.



• Create the eroding shape using the first shell.



• Using the *Removing* command, delete the superfluous faces and select **Extend** as the **heal type**.



D

• **Extend** the face using the **Faces Modification** command.

Faces Modification 1	
Faces:	
Face(Eroding Shape 1 - Theoretical:Face(309))	<b></b>
Shift:	
1,5mm	



• Limit the bottom of the electrode in relation to the face of the part and select the **Felectrode** command to obtain the result as shown below.



• Repeat the same procedure for the second shell to obtain the result as shown below.



On the part, you can plunge the first electrode in several places.

• Repeat the first electrode using a **linear pattern** with a value of *53mm*.



#### **Collision check**

To check the position of the repetitions, we will use the **Collisions** command.

Select the Select the Collisions command and adjust the following settings.

<b>⊻ × ?</b>
Collisions
O Refresh auto
Refresh manual
○ Not managed
Representation:
Design Representation $\sim$
✓ Intersections
Threading-tapping
Mechanisms
Invalid if colliding

We automatically switch to **Analysis** mode and a **Collisions** folder is created in the Entities tree. Since we have chosen to update the collision check manually, we have to restart the calculation using the



Collisions are detected.



Collisions between electrode bases are normal. To prevent them from reappearing as collisions, you can exclude them.

There is still a collision between the repetition of the first electrode and the part.

- Check the distance between the two areas to be burnt.
- Modify the pattern of the repetition.
- Relaunch the collision check.

**<u>Note</u>**: When the electrodes are repeated, the burnt areas are not deleted.

Delete the burnt areas using the *Appendix Removing* command.

#### Creating the part to be eroded

We are going to create a part without the areas to be eroded which can be based on to perform the machining operations. There are therefore no filled-hole surfaces to be created for the tool paths.

- Create a folder named *Part to be eroded* in the Project tree.
- Select the Parts to erode command.
- Click on 💙 to **confirm** the operation.
- Select the destination folder.

TopSolid

# **Exercise 11: Multi-directional Electrode**

In this chapter, we will make injection electrodes.

#### Creating an additional origin frame

The **Additional Origin Frame** command allows you to assign several origin frames to the shape to be eroded and to have different orientations. When the electrode is created, you can select the newly created frame as the **origin**.

- In the Electrode tab, select the 🚧 Additional Origin Frame command.
- Adjust the settings as shown below.



To create the **frame by point and 2 directions** constrain, you simply have to orient it along the injection point.

• Select the injection cone as the **Z direction** to orient the frame along the injection axis.

✓ X ?	
Frame by Point and 2	4
Origin:	
Absolute Frame 🗸 🕂	
X direction:	
🖌 -Absolute Y Axis 🗸 🕂	
○ Y direction	
Z direction	
🖊 Shape To Erode 1 ၊ 🗸 🕂	
<b>E</b> T	
$\mathbf{S}_{\mathbf{I}}$	$\land \qquad \bigcirc$
ŏ	

### Creating the electrode

- Create the shell corresponding to the two injection points.
- Fill the hole of the shell using the **Removing** command.



• Create an **eroding shape** by selecting the injection cone as the **direction**.

🖌 🗙 🟅	
Eroding Shape 3	
Shell:	
Shell 3 🗸 🕂	
Direction:	
▶         Shell 3:Face(1)         ✓         ⊕	
First extension	
Limit:	
Length	
2mm	
I	
✓ Follow draft	
Second extension	
Limit:	
15mm	
12°	
(🙀)	

Create an **electrode** with the **additional origin frame** previously created as **direction**.



### Drafting the injection electrode

To be able to orientate the drawing with the electrode along the Z axis of the erosion machine, we need to create a camera.

- To orientate the view, select the back face of the electrode base and create a normal view to this face.
- From the Entities tree, right-click on the **Cameras** folder and select the **Camera From View** command in order to create a new camera.



• Name the camera *Injection*.

• In the **Orientation** section, select the **injection** camera for the main view of the injection drafting.





**Note**: An exercise on the plunge injection electrode along a vector is available in the annex.

# **Exercise 12: Creating an Electrode Part Template**

### Introduction

When an electrode is generated, the template selected to create the part document is blank.

Accordingly, the part has no material and the physical properties are not calculated, which forces you to apply the material and ask for the properties to be calculated manually on each electrode.

To avoid this, you need to create a specific part template for the electrode.

#### *Creating the template with calculated stock dimensions*

- Click on the TopSolid 7 icon and select the File > Document Templates > Open My Templates command.
- Create an **Electrode** folder.
- Create a part document using the **Steel Part Metric** template.



- Rename the part document *Electrode Template*.
- From the Entities tree, open the **Parameters** folder and double-click on the **Stock Type** parameter.



Select Rectangular from the drop-down list.

🗸 🗙 🟅
Stock Type
Туре:
Stock Type 🗸 🗸
Name:
Stock Type
Value:
Rectangular ~

- Click on <sup>V</sup> to confirm the operation.
- From the Entities tree, open the Parameters > Stock Calculation > Rectangular folders, double-click on the BoxXSizeMargin, BoxYSizeMargin and BoxZSizeMargin parameters and enter margin values for the stock calculation.
- Click on 💙 to **confirm** the operation.

54

• From the **Construction** tab, select the **Parameters > Associate template to > Electrode** command.



• Check the Associate the template to: Electrode box and click on 💙 to confirm the operation.



#### Material

- From the **Tools** tab, select the **> Material and Coating** command, uncheck the **No material** box and select the **Copper** material.
- Bave the document.

Note: When creating the electrode, TopSolid will offer to select a document template.



You can also store the electrode template in the **Templates** > **Defaults** folder of the project template. In this way, the template will be selected by default and **TopSolid** will not offer again.



# **Exercise 13: Creating Customized Properties**

### Introduction

The gap properties or electrode properties are documents that come from the **TopSolid Electrode** library by default.

Other properties can be created in a user library. The simplest way to do this is to copy a property from the **TopSolid** library, paste it into your own library, and then make the necessary changes.

### Copying the gap properties

- Open the **TopSolid Electrode** library.
- From the **Gaps** folder, <sup>E</sup> copy the **Rough** and **Finish** properties.



- Click on the **V** TopSolid 7 icon and select the File > Wew Library command.
- Select **Blank Template** and rename the library User Electrode.
- Right-click on the library name and create a new **b** folder named *Gaps*.
- Right-click on the folder and 🧧 paste the previously copied properties.
- Rename the new properties User Rough and User Finish.
- Open the User Rough document.

Start Page 🔚 User Rough*			
Property definition			
Domain:			
Electrodes.Gaps ~			
Description:			
Rough			
Parameter:	-		
Rough ~			
	-		

**<u>Note</u>**: Do not modify the domain name since this field is used as a link to an electrode's gap.

- From the Entities tree, open the **Parameters** folder, double-click on the **Rough** parameter and adjust the value to *0.6mm*.
- Click on 💙 to **confirm** the operation.
- Isave the document.
- Repeat the procedure with the User Finish document by adjusting the value of the Finish parameter to 0.2mm.

In this way, when creating the next electrode, the customized gap properties will be available, provided that the library in which they are contained is referenced.

Spark gap			
Theoretical			
○ Applied			
	Name	Spark gap	
	Rough	0,8mm	
	Semi-finish	0,3mm	
	Finish	0,1mm	
	User Rough	0,5mm	
	User Finish	0,2mm	

### Creating an electrode property

To create a new finishing mode, e.g. CH 21, you simply have to follow the procedure below.

- Copy the **Properties** folder from the **TopSolid Electrode** library and paste it into your *User Electrode*.
- Open the **Properties** folder and then open the **Type of finishing mode** enumeration document.
- Add line CH 21.
- **b** Save and close the document.

Note: It is recommended to reference the **TopSolid Electrode** library to avoid duplicates in the dialog boxes.

# **Annex 1: Customized Marker Component**

### Introduction

This exercise will show you how to create a marker model that calibrates the base, in addition to the chamfer.



The existing models are stored in the **TopSolid Electrode** library. The simplest thing is to copy one of the models, paste it into a user library, rename it, and then make the changes.

### Copying the model

- Open the **TopSolid Electrode** library.
- From the Markers folder, select the Chamfer family document and generic document.



- **Copy** the two documents.
- Open the User Electrode library (created in a previous exercise).
- Create a new folder and rename it Markers.
- **Final Paste** the previously copied documents into the new folder.
- Rename the documents *Chamfer + Calibration*.

### Modification

- Open the part document *Chamfer*.
- Right-click on the chamfer sketch and create a new *ketch*.
- Create a rectangle using the BaseLength and BaseWidth parameters as shown below.



From the 2D Sketch tab's drop-down menu, select the Operations > Project command in Profiles or loops mode and project the chamfer shape.



From the 2D Sketch tab's drop-down menu, select the Operations > 🖗 Boolean command in 论 Subtraction • mode and create a Boolean operation based on the two previously created profiles by selecting the rectangle as the profile to be modified and the triangle as the **tool section**.



- to **confirm** the operation. Click on 🗡
- Extrude the contour by checking the Parallelize box and creating two Ch and Cw parameters on the fly for the calibration height and width.

🖌 🛪 🖮 ;	
Extruded	
Section:	
🤜 Sketch 1 🔍 🕂	
Direction:	
Z Sketch 1 🗸 🕂	
Limit:	
Length $\checkmark$	
Ch=2mm	
Center	
Draft:	
Parallelize	<b>⊥</b> 0 <sup>★</sup>
Туре:	
Thickness:	
Cw=2mm	
Rounded joints	
<b>8</b>	

- Click on  $\checkmark$  to **confirm** the operation.
- Unite the new shape with the chamfer shape. Make sure you select the chamfer shape as the shape to modify.
- Save the document.

- Open the family document.
- From the Entities tree, open the **Generics** folder and 🗳 drag the **Ch** and **Cw** parameters to the **Drivers** folder.
- Modify the descriptions as shown below.

💡 Dri	vers (9)
++++++++++++++++++++++++++++++++++++	Optional Drivers (0)
- 3	FirstDistance (First Distance)
- 20	SecondDistance (Second Distance)
- 20	BaseHeight (Base Height)
- 20	BaseLength (Base Length)
- 20	BaseWidth (Base Width)
- 5	Corner Type (Corner Type)
- 20	Ch (Calibration Height)
-	Cw (Calibration Width)

- 😼 Save the document.
- Check the documents into the vault.

#### Testing the component

- Open the electrodes document named *Core Block*.
- Section 2 Construction of the first electrode.
- Select the **Chamfer + Calibration** template and adjust the following settings.



• Click on 💙 to **confirm** the operation.

# **Annex 2: Creating a Customized Mandrel**

### Parasolid import

• From the *TopSolid'Electrode Training* Project tree, right-click on the file named *electrode\_holder* and select the **Convert Document** command.

Translator na	me:	arasolid			
File name:		electrode_hole	der.x_t		
General	Simplification and se	wing 1	lemplates		
Document	type for shapes:		<b>P</b> Part		_
Document	type for assemblies:		Assembly	 	
✓ Translate	attributes				
✓ Translate	attributes				

• Click on 💙 to **confirm** the operation.

### Providing the Mandrel function

- From the **Tools** tab, select the **Functions** > • • Provide Function command.
- Select the **Mandrel** function.
- Click on 💙 to **confirm** the operation.
- For the mandrel frame, click on the <table-cell-rows> icon and create the 🖙 frame on plane constrain as shown below.

<b>∀</b> × <b>∛</b> ?	
Erame on Plane	
O Intersection axis Center:electrode_h ∨ ⊕	
X direction:	0

• Click on 💙 to **confirm** the operation.

• For the base frame, click on the <table-cell-rows> icon and create the 😓 frame on plane constrain as shown below.



You should obtain the following result.

land	drel
P	ublishings
Mar	ndrel Frame
7	Frame 1 (electrode_holder)
Base	e Frame
7	Frame 2 (electrode_holder)

- Click on 💙 to **confirm** the operation.



## Annex 3: Creating a vector plunge electrode

• Open the electrodes document named P1.Cavity block.

### Creating the electrode

- Create the shell for the injection electrode.
- Create the eroding shape as shown below by making sure that the **Z** axis of frame 1 is selected as the direction. Check the **Third extension** option and select a plane as the **limit**.

✓ׇ ?		
Froding Shape	-	
Shell:		
Shell 4	•	
Direction:	]	
	÷	
First extension		
Length	~	
7mm		
Follow draft		
<b>G</b>		
Third extension		
Limit		
Plane	~	
Plane 1	a	
		Creation
Direction:	۲	Midplane
Absolute Z Axis	-	Offset Plane
	٤	Pivoted Plane
<u> </u>	2	Plane by 3 Points
		Plane by Axis
<b></b>	J	Plane by Point and Normal
	P	Plane on Profile
	-	Plane
	22	Basify
7	Ø	Analyze
4	_	

<u>Note</u>: To select the direction, you can click directly on the shell in the graphics area. The third extension allows you to create the base along the Z axis of the block.

✓ × ?	
Offset Plane	
Reference plane:	
🍠 Shape To Erode 1 i 🗸 🕂	
Offset distance:	
4mm	
Reverse	

• Create the electrode as shown below.

🗸 🗶 🗍 🥶
Electrode
Name:
Electrode6
Eroding shapes:
Eroding Shape 4 - Theoretical
Hide
Base
Origin frame:
🎵 Frame (Shapes To Burn Set 1) 🛛 🗸 💠
Centered
X position:
-39,899524mm
Y position:
-20,556485mm
Definition
771
X Direction:
🖊 Frame (Shapes To Burn Set 1):X 🗸 💠
X length:
14mm
Y length:
14mm
Z length:
15mm
Default values

<u>Note</u>: To create a connection radius, you simply have to **edit the part in-place**, **delete** the unnecessary faces and select the **Fillet** command.

### Creating the start position

• Select the **F** Repetition command and create a linear pattern by selecting the injection cone as the direction.

V X ?	
Type: Direction Total distance Spacing distance 10mm Total count: 2 Alternated numbering	

- Click on ✓ to confirm the pattern and the repetition.
- 📕 Save the document.
## Creating the drafting document

• Select the Electrodes Draft command.



To avoid overloading the view, you can create exceptions on the views and apply them to certain parts. You can change the color of the lines, to make a part unbreakable, etc.

- Right-click on the sectional view and select the **Exception** command.
- Create a new style.

Exception			×		
Source	Style				
P1.Cavity block-V2 <143>	Normal		$\sim$		
	Normal		$\sim$		
Electrode6 <337>	Normal		~ 🕈		
				Creation	
			82	Exception Style	J
			_		2
✓ :	× ?	 			

- Check the **Visible lines** box.
- Select the type of line and the color as shown below.

✓ × ?	
Exception Style	
Name:	
Exception Style 1	
Visibility	
Visible	~
Lines	
Visible lines	
Visible	~
Half tone	
Hidden lines	
Hidden	~
<unspecified></unspecified>	<unspecified></unspecified>
Half tone	

- Click on 💙 to **confirm** the operation.
- To remove the hatchings on the starting electrode, right-click on the starting electrode and **edit** the hatchings.
- For the **type**, select **Transparent** as shown below.

🗸 🗙 🥇
Rart
🗹 Туре:
///-
Transparent Transparent 意 記 記 記 記 記 記 記 記 記 記 記 記 記
0mm
Y:
0mm
Color:
<unspecified> 🥜 🗙</unspecified>
Layer:
~ +

You should obtain the following result.



# Annex 4: Machining an electrode

## Machining an electrode

- Right-click on the electrodes document to be machined and select the GMAChining command.
- Select the desired machine model.
- Select the gap to be applied to the electrode.

**<u>Note</u>**: These gaps correspond to the theoretical gaps that were selected when designing the electrode.

Creation	of Machinable Part	
- 🤕 Stoc	k	
Bloc	k Cylinder	No stock Offset
Exa	AachineW	if stock
Electro	de gaps	
	Name	Value
۲	Rough	0,8mm
0	Semi-finish	0,3mm
0	Finish	0,1mm
0	User defined	
		✓ ?

**<u>Note</u>**: The electrode gap is applied directly to the tool path.

## Machining and positioning origins

<u>Note</u>: If you want the **machining positioning frame** and the **machining frame** defined in the electrodes document to be taken into account, in the machining document, you simply have to adjust the options as shown below.



• Select a machining method to create the electrode or to machine the electrode in the traditional way.

<u>Warning</u>: When finishing, you must keep the value of the offset at 0. The gap is automatically applied. The gap appears in the NC Operations tree: **Rough=0.8 (Rough) (theoretical)**.



#### Machining verification

• Check the machining using the **Start in turbo mode** command.

Before launching the comparison command, we will configure this mode.

• From the Entities tree, select the **11** Settings command.



- Check the Offset comparison (3D Z-buffer only) box.
- Check the Electrode gap (if applicable) box.

W Settings								-		×
deneral	*	Incidents	4	Comparison	Z-buffer		Animation	<u>.</u>	Display	
Tolerance	es									\$
Stocks faceti	ng toler	ance								
0,03mm										
Comparison	tolerand	e								
0,05mm		ß								
✓ Offset co	omparis	on (3D Z-buf	fer on	ly)						\$
Custom valu	e									
0mm										
Electrode	gap (if a	pplicable)								
Legend										\$
	-	0.15		0.05	0.05		0.15			
-(	,2	-0,15	-0,1	-0,05	0,05	0,1	0,15	(	),2	
			_							
					٠ 🖌					

Select the *Head Display comparison* command.

The part should appear in green if it is finished. The comparison takes into account the gap, as indicated in the color legends below.



We performed a roughing electrode operation. To perform a finishing electrode, you simply have to follow the procedure below.

#### Machining the finishing electrode

- **Copy** and **paste** the rough electrode machining document and rename it *Finishing*.
- Open the electrode finishing document.
- From the NC Operations tree, right-click on Machined Part 1 and select the Others > Select Machined Part command.



• Select the finishing gap.

🎕 Edit	Machined Part			$\times$
🡼 Sto	k			
		2		
Exa	ct MachineW			
CZ Elimi	aste the weak portions of	fistock		
	tate the weak portions of	SLOCK		
Criec	k the geometry of stock.			
Electro	de gaps			
	Name	Value		
0	Rough	0,8mm		
0	Semi-finish	0,3mm		
•	Finish	0,1mm		
0	User defined			
		2 🗙 ?		
	· · · · ·	•••	 	

- Restart the machining sequence using the Fresh command.
- 🔛 Save the document.

# Annex 5: Electrode Drafting Template

## Creating the drafting document

- Right-click on the *TopSolid'Electrode Training* project name and create a **by drafting**.
- Select **Blank Template** and click on  $\checkmark$  to **confirm** the operation.
- Rename the drafting document *Electrode End positions*.
- Right-click in the drawing, select the 🕓 Format command and select the A3 ISO Landscape format.
- Solution of the Core Block electrodes document into the graphics area.
- Adjust the following settings.

< >	۲ (				
<b>?</b>	Set				
Source	document:				
🍸 Co	re Block				~
O As Ele Repres	sembly ectrodes entation:				
Detaile	ed Representati	on			$\sim$
🗹 Sha	pes To Erode				
Che	ck all electrode	25			
	Name	Theoretical positions	Control points	Mandrels	^
	Electrode 1				
	Electrode 2				
	Electrode 3				
	Electrode 4				
	Electrode 5				
	Electrode 6				~

- Click on  $\checkmark$  to **confirm** the operation.
- Position the views as shown below.



• From the Project tree, drag the **electrode 4** into the graphics area, select **Electrode Camera**, check the **Associative** box and place the view outside of the drawing.





- Click on 💙 to **confirm** the operation.
- Place the auxiliary view as shown below in order to produce a perspective view.



• Click on 💙 to **confirm** the operation.

#### Layout sketch

**<u>Note</u>**: The **Layout sketch** command allows you to create different rectangles which will be used to position the views which will be attached to them. Each view will be placed in a rectangle when using the **Optimize View Layout** command.

- From the **View** tab, select the **Layout Sketch** command.
- Set the dimensions for the profiles as shown below.



Confirm the layout sketch by clicking on the

View Layout Sketch button.

• Select the **Optimize View Layout** command.

#### View origins

- Right-click on the main view and signal edit the projection.
- Click on the Advanced Options icon. In the 3D reference point field, select the Manual option and select Absolute Origin Point from the drop-down list.

3D reference point	
<ul> <li>Automatic</li> </ul>	
Manual	
Absolute Origin Point	~

- Click on 💙 to **confirm** the operation.
- Right-click on the main view and select the Edit Detailing command.

• Select the  $\triangle$  Symbol command, select the Origin model and place the view's absolute frame.

🗙 🛰 🐜 ?
Model:
🚏 Origin 🛛 🗸 🗸
Key point:
Center ~
Fix orientation
Paper size
○ Model size
Drivers
Drivers
Diameter:
5mm

- **Confirm** the view detailing by clicking on the **Detailing** button.
- Repeat the procedure on the left view.





### Electrode note and table

- From the Electrode tab, select the Automatic Electrode Note command.
- Select the main view and click on  $\checkmark$  to **confirm** the operation.



• Select the Electrodes Table command. Click on a first point, and then click on a second point to position the table.

-	Electrodes Table   Set:   Main Set (Core Block)   First point or segment:   Border:Vertex(9)   Second point:   Border:Vertex(12)		,
		А	

- Click on 💙 to **confirm** the operation.
- Right-click on the first column and select the **Insert Right Column** command.



- Double-click on the bottom left cell.
- Click on the <table-cell-rows> icon to access the properties.

✓ × ?
📁 Property Text 1
Туре:
Property $\vee$
Properties:
* *
Formula:
<ul> <li>Text</li> </ul>
<ul> <li>Numerical</li> </ul>
Text:
Angle:
0"
Style:
Centered V

• Open the **Standard > Root > General** categories and select the **Name** property.

		- C	]
ber			
	ber	ber	ber

• Click on 💙 to **confirm** the operation.

• From the **Electrode** category, insert the **Gap values** property in the second column.

Floperty		×
Property:		
<ul> <li>Standard</li> <li>Bronension</li> <li>Document</li> <li>Drafting</li> <li>Electrode</li> <li>Base diameter</li> <li>Base height</li> </ul>	,,	~
Electrode End positions Gap values		
Position index     Theoretical gap     Theoretical position count     X coordinate     Y coordinate     Z coordinate     General     General     Machining		*
Position index     Theoretical gap     Theoretical position count     X coordinate     Y coordinate     Z coordinate     General     Machining  Format		•
Format		~
Position index     Position index     Theoretical gap     Theoretical position count     X coordinate     Y coordinate     General     Onderse     Machining  Format  Number of decimals: Unit:		~
Position index     Position index     Theoretical gap     Theoretical position count     X coordinate     Y coordinate     General     Machining  Format Number of decimals: Unit: Preview:		~

- Click on 💙 to **confirm** the operation.
- Insert the **Base dimensions** property in the third column.

Property	_	×
Property:		
- Standard  - Root  - Dimension  - Document  - Drafting  - Electrode  - Base diameter - Base diameter - Base height		~

• Insert the **End positions** property in the last column.

Property		×
Property:		
		^
🖅 Dimension		
🖽 Drafting		
🖃 Electrode		
Base diameter		
Base dimensions		
Base height		
Base length		
Base width		
C Angle		
Electrode		
End positions		
Gap values		

- Adjust the size of the columns for better readability.
- Confirm the electrode table by clicking on the Electrodes Table 1 button.

#### Breaking the link

- To break the link with the Electrodes document, right-click on the first view and select the **K** Edit Set command.
- In the **Source Document** field, select **Unspecified**.
- Repeat the procedure for the view with the single electrode.

Set (Main Set	(Core Block))			
Source document:				
😈 Core Block		~		
🍞 Core Block				
<unspecified></unspecified>	011	<b>.</b>		
Shapes To Erode				
Check all electrode	s			
Name		Theoretical positions		
Electrode 1				
Electrode 2				
Electrode 3				
Electrode /				
Liectione 4				

- Click on 💙 to **confirm** the operation.
- **I** Save the document.
- Copy and paste the drafting document into Y My Templates or Company Templates.

**<u>Note</u>**: The drafting template must be used with the **Electrodes Draft** command.

# Notes


NO 

Good 

7

Good

Good

Excellent

Excellent

Excellent

10

9

8

# **Individual Course Evaluation Form**

(To be completed and returned to the training instructor at the end of the course)

# **TopSolid'Electrode 7**

Name	:	
Company	:	
Date(s)	from to	

By completing this individual evaluation form, you are helping to improve the quality and usefulness of the training provided in the future. Please complete it carefully.

Number of people during the course:	Onsite at your	company?	YES 🗆
	,	. ,	
GENERAL ASSESSMENT	Poor	Average	Goo
Overall, this course has been:			
What grade would you assign?	0 1	2 3 4 5	567
LOGISTIC	Poor	Average	Goo
Orientation (quality, organization, user-friendliness, etc.)			
Physical setup (room, materials, etc.)			
TRAINING	Poor	Average	Goo
Instructor's teaching method			
Group relationship (participation, sharing of experiences)			
Quality and clarity of educational materials (documentation)			
Balance between Theory and Practice			
Consistent presentations with what has been announced			
Training Content			
DURATION	No	Somewhat ne	o Somewh
Does the overall duration of the course seem appropriate?			
If no, was it?	Тос	o short 🛛	

PACE Does the overall pace of the course seem appropriate? If no, was it?

USE OF ACQUIRED KNOWLEDGE IN THIS TRAINING			
Have you found this training to be useful in your work?			
Do you think you can put the acquired knowledge into use quickly?			
Do you believe that you have achieved your objectives			
upon completion of this course?			

Comments and suggestions:

No	Some	ewhat no	Somewhat yes	Yes	
Too sh	nort		Too long		
No	Some	ewhat no	Somewhat yes	Yes	
Too s	low		Too fast		
Too s	low		Too fast		
Too s No	low Some	□ ewhat no	Too fast Somewhat yes	□ Yes	
Too s No	low Some	ewhat no	Too fast Somewhat yes	□ Yes	
Too s No 	low Some	ewhat no	Too fast Somewhat yes	□ Yes □	
Too s No	Some	ewhat no	Too fast Somewhat yes 	□ Yes □	

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	220	uч