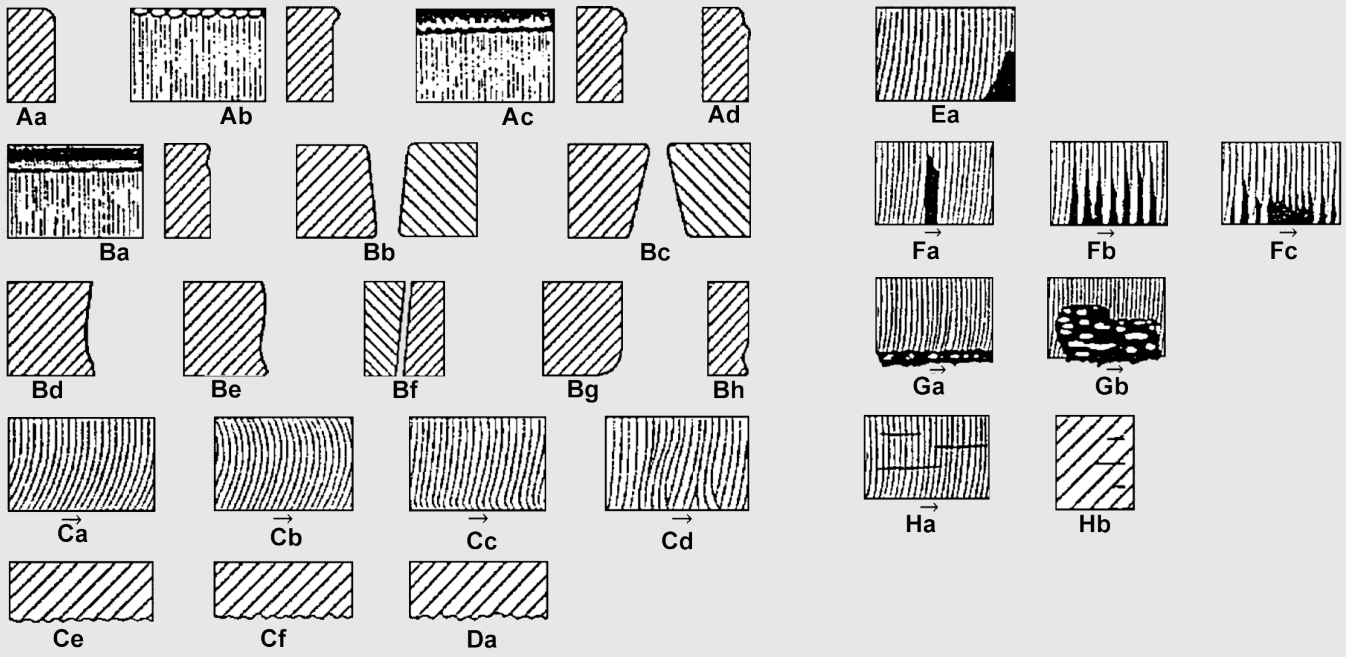
CUTTING
WELDING

SINCE 1898

ZINSER

Flame cut imperfections

Description of faults and their causes



Made in Germany
Since 1898

Dear customer,

The oxy-fuel flame cutting process has developed into a production process with a large range of applications. High-quality nozzles and machines allow the production of accurate components with a high-quality cut face according to DIN 2310.

But even the best machine will not give a guarantee for perfect flame cuts. An equally important role is played by a skilled and carefull staff. Only well-maintained nozzles and machines as well as their correct adjustment will give an optimum cutting quality.

This document is meant to be used as an instruction and assistance during work in order to avoid imperfect cuts and the resulting finishing work.

These instructions have been compiled (with the kind consent of Dipl.-Ing. P. Bernard Knapsack) on the basis of a corresponding document of the BEFA Association.

Wording and illustrations in this document have been arranged with utmost care. Nevertheless, errors may occur.

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Composition and structure

This document is structured into a survey table and the corresponding explanations.

The survey table has been structured in a way to show potential imperfections in horizontal direction and their causes in vertical direction.
Faults are grouped and marked with capital letters.
The individual faults are marked with small letters as e. g. Aa, Ab,.. to Hb.
Causes are numbered from 01 to 35.
With this method you have sections, that have been arranged in different ways depending on the grade of the cause.

 Main cause

 Second grade cause

 Third grade cause

Some faults may have several causes, e. g. “flame too strong” can mean that the quantity of gas is too big or the exhaust speed too high.

Furthermore, faults are also shown in reduced size in the table.

The explanations include the fault groups and the individual faults.
The fault is shown in a sketch and defined in detail. Potential causes are explained.

With the help of this document defects occurring during flame cutting can be defined and their potential causes can be found and eliminated. In this context you should pay attention to the fact that some causes of defects may lead to contrary occurences upon interaction with others.

Analysis of the defects does not take into consideration errors occuring from the machine (e. g. own or separately excited vibrations). A sufficient purity of oxygen is also taken for granted.

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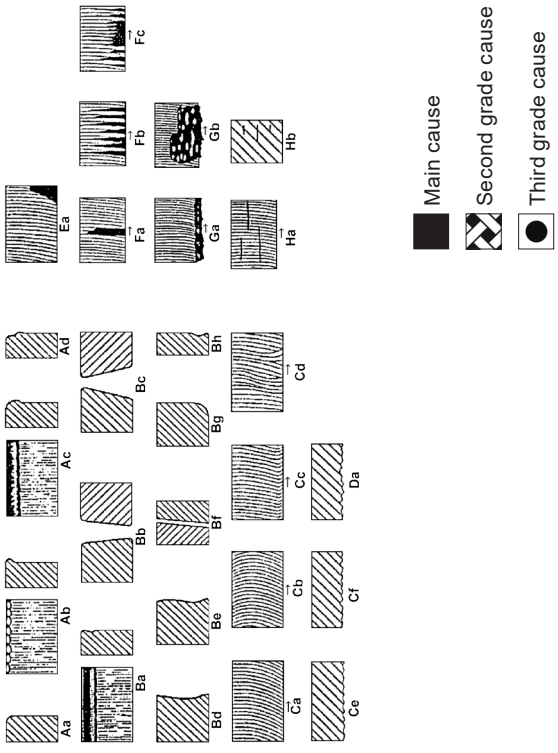
Imperfections in oxyfuel flame cuts

Causes			Imperfections			
Torches	Torch not in correct angle in cutting direction	01	Imperfections on edges:	A	a	Edge melting off
	Torch not in correct angle in transverse to cutt. direc.	02			b	String of solidified droplets
	Forward speed of torch too fast	03			c	Cut edge overhang
	Forward speed of torch too slow	04			d	Melted down top edge with adherent slag
	Irregular forward speed of torch	05	Imperfections on cut surfaces: Unevenness	B	a	Concave cut surface beneath top edge
Heating and cutting nozzle (jointly)	Distance between nozzle and metal sheet too big	06			b	Narrowing of kerf (convergent)
	Distance between nozzle and metal sheet too small	07			c	Narrowing of kerf (divergent)
	Nozzle size too big for the thickness to be cut	08			d	Concave cut surface profile
	Nozzle size too small for the thickness to be cut	09			e	Irregular cut surface profile
	Dirty nozzle	10			f	Angle deviation of cut surfaces
	Damaged or worn nozzle	11			g	Rounded bottom edge
Heating nozzle	Flame too weak	12			h	Step at bottom edge
	Flame too strong	13	Imperfections on cut surfaces: Imperfections in drag lines	C	a	Excessive run of cut drag line
	Flame extinguished with a bang	14			b	Upper lead of cut drag line
	Flame with surplus of fuel gas	15			c	Lead of cut drag line too big at the bottom
	Flame with excessive surplus of oxygen	16			d	Local deviation of cut drag line
Cutting nozzle	Quantity of cutting oxygen too big	17			e	Excessive cut drag line depth
	Quantity of cutting oxygen too small	18			f	Irregular cut drag line depth
	Flow of cutting oxygen shortly interrupted	19	Imperfections on cut surfaces:	D	a	Wavy cut surface in cutting direction
	Cutting oxygen pressure too high	20	Imperfections on cut surfaces: Incomplete cuts	E	a	Incomplete end of cut
	Cutting oxygen pressure too low	21			b	Interruption of cutting operation
	Interrupted beam of cutting oxygen	22	Gouges:	F	a	Isolated gouges
	Deviated beam of cutting oxygen	23			b	Grouped gouge areas
Sheet metal	Scaled or corroded sheet metal surface	24			c	Grouped gouges in the bottom half of the cut
	Dirty sheet metal surface	25	Adherent slag:	G	a	Slag adhering to bottom cut edge
	Sheet metal with liquations	26			b	Slag patch on cut surface
	Double drawn sheet metal	27	Cracks:	H	a	On cut surface
	Sheet with slag inclusions	28			b	Beneath cut surface
	Sheet with finely divided inclusions	29				
Material	Carbon content too high	30				
	Content of alloy admixtures too high	31				
	Steel involving a higher risk of warm cracks	32				
	Preheating time of the material not sufficient	33				
	Workpiece cooled down too fast	34				
	Material cold-hardened	35				



Fault group A

Damaged edge (upper edge of cut)

Damaged upper edge of cut caused by melting on or material removal.

a) Edge melting on

Signs: Too much melting (round edge).

Causes:

- forward speed of torch too slow
- heating flame too strong

- distance between nozzle and sheet metal too big or too small
- nozzle size too big for the thickness to be cut
- flame with surplus of oxygen

b) String of solidified droplets

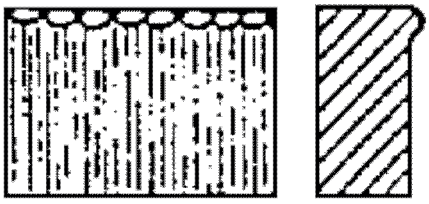
Signs: A string of solidified droplets forms on the edge of cut.

Causes:

- scaled or corroded sheet metal surface

- distance between nozzle and sheet metal too small
- heating flame too strong

- distance between nozzle and sheet metal too big

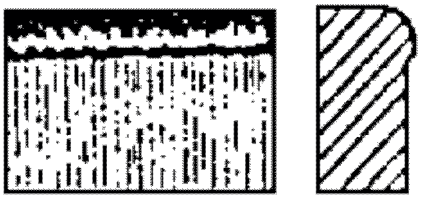


c) Cut edge overhang

Signs: Continuous overhang forms on the edge of cut.

Causes:

- heating flame too strong
- distance between nozzle and sheet metal too small
- forward speed of torch too slow
- distance between nozzle and sheet metal too big
- nozzle size too big for the thickness to be cut
- flame with surplus of fuel gas

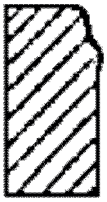


d) Melted down top edge with adherent slag

Signs: Material is removed from top edge.

Causes:

- distance between nozzle and sheet metal too big
- cutting oxygen pressure too high
- heating flame too strong



Fault group B

Faulty cut surface: unevenness

All tolerances with respect to the perfect cut surface. Unevenness of cut surface means the distance between two parallel lines which touch the cut surface profile in its highest and deepest point (DIN 2310 sheet 1) under a theoretically correct angle (90° for vertical cuts).

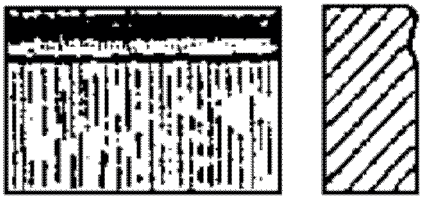
a) Concave cut surface beneath top edge

Signs: Upper area of cut surface is concave beneath the edge of cut.
The edge of cut itself may be more or less melted on.

Causes:

- cutting oxygen pressure too high

- distance between nozzle and sheet metal too big
- dirty nozzle
- interrupted beam of cutting oxygen



b) Narrowing of kerf (convergent)

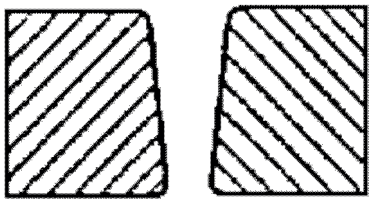
Signs: Both cut surfaces meet in the lower area.

Causes:

- forward speed of torch too fast

- distance between nozzle and sheet metal too big
- dirty nozzle
- interrupted beam of cutting oxygen

- nozzle size too small for the thickness to be cut

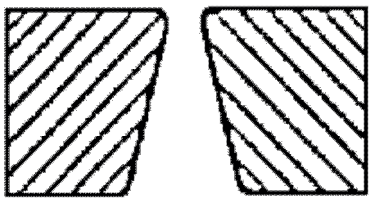


c) Narrowing of kerf (divergent)

Signs: Both cut surfaces follow opposite directions.

Causes:

- forward speed of torch too fast
- cutting oxygen pressure too high
- quantity of cutting oxygen too big
- distance between nozzle and sheet metal too big

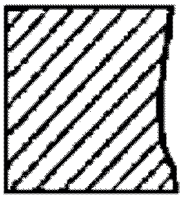


d) Concave cut surface profile

Signs: Concave cut surface over the whole depth of cut especially in the centre area.

Causes:

- forward speed of torch too fast
- nozzle size too small for the thickness to be cut
- cutting oxygen pressure too low
- dirty and / or damaged nozzle
- cutting oxygen pressure too high
- interrupted beam of cutting oxygen



e) Irregular cut surface profile

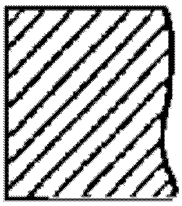
Signs: Cut surface profile is irregular in the direction of cut depth which means that it is both concave and convexe.

Causes:

- forward speed of torch too fast

- dirty and / or damaged nozzle
- cutting oxygen pressure too low
- interrupted beam of cutting oxygen

- nozzle size too big for the thickness to be cut



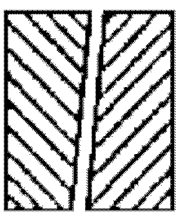
f) Angle deviation of cut surfaces

Signs: Cut surface profile is not following the theoretically correct angle.
In addition, other defects to the cut surface may occur.

Causes:

- torch in wrong angle in transverse direction to the cutting direction.

- deviated cutting oxygen beam



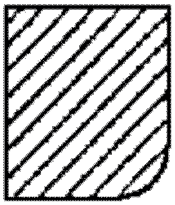
g) Rounded bottom edge

Signs: The bottom edge of cut is more or less melted on.

Causes:

- dirty and / or damaged nozzle
- interrupted beam of cutting oxygen

- forward speed of torch too fast
- cutting oxygen pressure too high



h) Step at bottom edge

Signs: Edge melted on while lower area of cut surface is concave.

Causes:

- forward speed of torch too fast
- dirty and / or damaged nozzle
- interrupted beam of cutting oxygen

Fault group C

Impert on cut surface: imperfection in drag line

All deviations from the normal form of the drag line with respect to the course of the drag line and its depth. Admitted tolerances of the depth of the drag line are determined in DIN 2310 sheet 1.

a) Excessive run of cut drag line

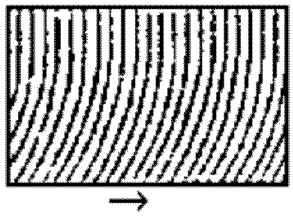
Signs: Extremely strong backward inclination of the drag line. Normally, combined with a certain concavity depending on the strength of inclination.
Both defects may aggravate constructional usability of the cut part.

Causes:

- forward speed of torch too fast

- nozzle size too small for the thickness to be cut
- quantity of cutting oxygen too small
- cutting oxyen pressure too low

- distance between nozzle and sheet metal too big



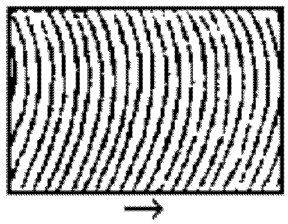
b) Upper lead of cut drag line

Signs: More or less expressed lead of drag line at the top edge which gradually becomes normal lead of drag line.

Causes:

- torch not in correct angle in cutting direction

- dirty and / or damaged nozzle
- interrupted beam of cutting oxygen

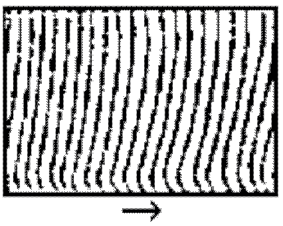


c) Lead of drag line too big at the bottom

Signs: Inclination of drag line at bottom edge in cutting direction, visible on the cut surface, exceeding normal extent.

Causes:

- dirty and / or damaged nozzle
- interrupted beam of cutting oxygen
- deviated beam of cutting oxygen

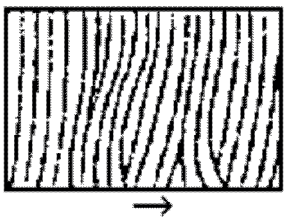


d) Local deviation of cut drag line

Signs: Forward and / or backward deviation of drag line from homogeneous course of drag line. The position of the deviation may vary over the whole cutting thickness.

Causes:

- sheet metal with liquations, slag inclusions or finely divided inclusions
- irregular forward speed of torch



e) Excessive cut drag line depth

Signs: Groove-type form of cut surface in direction of the cut drag line depth. Bound to the drag line but independent from the course of the drag line (possible with run and lead of drag line).

Causes:

- forward speed of torch too fast or irregular

- distance between nozzle and sheet metal too small
- flame too strong
- content of alloy admixtures too high

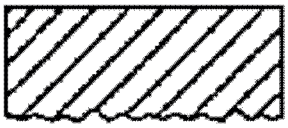
f) Irregular depth of cut drag line

Signs: Normal to excessive variation of cut depth (Ce).

Causes:

- forward speed of torch too fast or irregular

- flame too weak



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Fault group D

Imperfect cut surface: in cutting direction

a) Wavy cut surface in cutting direction

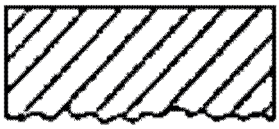
Signs: Prominences and depressions in cutting direction not bound to the drag line.

Causes:

- forward speed of torch too fast
- content of alloy admixtures too high

- dirty and / or damaged nozzle
- flame with surplus of fuel gas
- interrupted beam of cutting oxygen
- carbon content too high

- irregular forward speed of torch
- nozzle size too big for the thickness to be cut



Fault group E

Imperfect cut surface: incomplete cuts

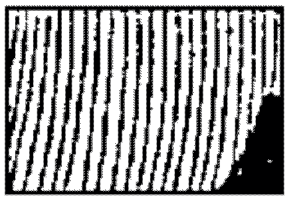
Cut is interrupted before it is ready. A continuing cut surface to the end of cut cannot be received.

a) Incomplete end of cut

Signs: Cut surface with remaining triangle at the end of cut.

Causes:

- Forward speed of torch too fast



b) Interrupted cutting operation

Signs: Cut ends within the sheet metal.

Causes:

- forward speed of torch too fast
- nozzle size too small for the thickness to be cut
- dirty and / or damaged nozzle
- flame too weak
- interrupted beam of cutting oxygen
- dirty sheet metal surface
- double drawn sheet metal

- distance between torch and sheet metal too big
- quantity of cutting oxygen too small
- scaled or corroded sheet metal surface
- sheet metal with liquations and/or slag inclusions

- flame extinguished with a bang
- sheet metal with finely divided inclusions

Fault group F

Gouges

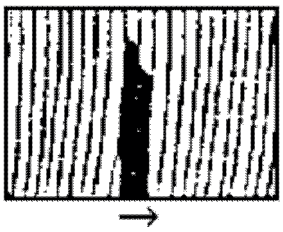
Single or grouped irregular sections of washouts of limited size on the cut surface. Especially in direction of the cutting beam. Depth and width of the washouts is exceeding the cut drag line.

a) Single gouges

Signs: Occurence of washouts in irregular (wide) intervals.

Causes:

- flame extinguished with a bang
- flow of cutting oxygen shortly interrupted
- scaled, corroded or dirty sheet metal surface
- sheet metal with finely divided inclusions
- flame too weak

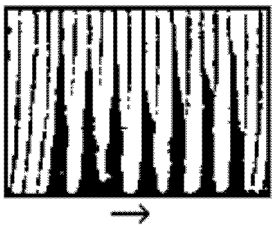


b) Grouped gouge areas

Signs: Occurence of washouts in irregular narrow intervals or grouped washouts.

Causes:

- forward speed of torch too fast
- scaled, corroded or dirty sheet metal surface
- distance between nozzle and sheet metal too small
- flame too weak

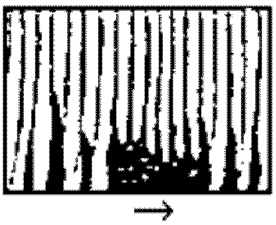


c) Grouped gouges in the bottom half of the cut

Signs: Occurence of washouts in irregular intervals and in the lower area of cut.

Causes:

- forward speed of torch too slow
- dirty and / or damaged nozzle
- interrupted beam of cutting oxygen
- flame too weak



Fault group G

Adherent slag

Firmly adherent and hard to remove slag deposit at the lower edge of cut or on the cut surface.

a) Slag line

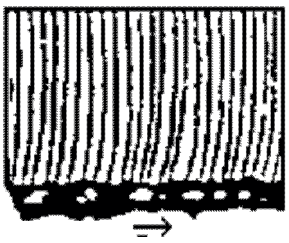
Signs: Firmly adherent slag at bottom edge.

Causes:

- forward speed of torch too fast or too slow
- nozzle size too small for the thickness to be cut
- pressure of cutting oxygen too low

- flame with surplus of fuel gas
- scaled, corroded or dirty sheet metal surface

- distance between nozzle and sheet metal too big
- flame too strong

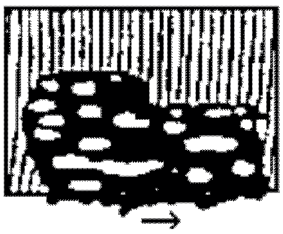


b) Slag patch

Signs: Firmly adherent slag on the cut surface. Especially in the lower section.

Causes:

- content of alloy admixtures too high



Fault group H

Cracks

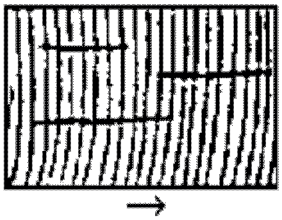
Cracks may occur in or beneath the cut surface and depend on the material. Visible cracks moren often occur.

a) Cracks in the cut surface

Signs: Visible cracks on the material.

Causes:

- carbon content or content of alloy admixtures too high
- steel involving a risk of warm cracks
- preheating of the workpiece not sufficient
- workpiece cooled down too fast
- material cold-hardened

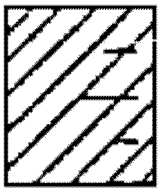


b) Cracks beneath cut surface

Signs: Cracks occuring inside the material near the cut surfaces which are only visible in the cross section resp. during cross polishing.

Causes:

- carbon content or content of alloy admixtures too high
- steel involving a risk of warm cracks
- preheating of the workpiece not sufficient
- workpiece cooled down too fast
- material cold-hardened



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