ALUMINIUM HIGH PRESSURE DIE CASTING DEFECTS ANALYSIS CHART

DEFECT TYPE

SHORT FILL
MAIN CAUSES: Metal is frozen before the cavity is filled or by insufficient metal being ladled.

COLD SHUT
MAIN CAUSES: Metal is frozen when two metal fronts join.

SCALING
MAIN CAUSES: Layers of metal and oxides can be created by poor shot end control and/or bad gate and runner design.

BLISTER
MAIN CAUSES: Trapped gases are in csting when the die is opened when the casting is still weak. This allows the compressed gas to expand and cause a blister.

FLASH
MAIN CAUSES: Metal pressure is too high upon the projected area of the casting at the end of cavity fill. This creates a force across the parting line which is too great for the clamping force of the machine. The die is then forced apart which allows metal to escape.

COLDFLAKES
MAIN CAUSES: Metal is allowed to cool too much in the shot sleeve. The solid particles are then injected in to the cavity. These flakes are often clearly visible on the surface of the casting with the naked dye.

SHOT LUBE STAIN
MAIN CAUSES: This defect occurs when too much shot (tip) lube is used.

AIR POROSITY
MAIN CAUSES: This defect is caused by trapped air in the casting which can come from several sources. It can be caused by poor shot end control, poor venting and overflow function or bad gating and runner design.

DRAG MARKS
MAIN CAUSES: Insufficient draft or an undercut causing a casting to be damaged on the surface when it is ejected. This effect may be reduced by changing the temperature at which the casting is ejected. Poor surface finish of the die can be another cause.

HOT TEARING/CRACKING
MAIN CAUSES: This defect is caused by metal shrinking during solidification while under tension. At the last place to solidify a tear or crack develops which can be seen at the surface (Not HOT SHORTNESS)

HOT SHORTNESS
MAIN CAUSES: The composition of the alloy causes the metal to be too weak at high temperatures (after soldification). This then can cause cracks in the surface of the casting to appear in regions of high stress when the casting is cooling (and contracting). NOTE: This defect can occur in conjuction with hot cracking.

SINK
MAIN CAUSES: A sink is caused by a shrinkage cavity being near the surface of the casting. This causes the surface of the casting to collapse into the cavity as soldification occurs. Sinks are caused by the same things as shrinkage porosity as well as very poor thermal control of the die because hot spots are required for sinks to form.

EXPLODED METAL
MAIN CAUSES: A combination of porosity and the casting being ejected before it has solidified completely. This allows the trapped gasses to burst out of the casting along with any unsolidified metal.

WARPAGE
MAIN CAUSES: A casting can deform after ejecting during the time it is cooling down to room temperature. The root cause can sometimes be the casting geometry or the alloy specification. Warpage can be minimised by ejecting at a lower temerature. Uneven die temperature is a major cause of this type of defect.

SOLDERING
MAIN CAUSES: Chemical attack and bonding of aluminium to die steel. This causes aluminium to be torn away from the casting during ejection. Soldering can be reduced be a change in ally and/or a reduction in die/metal temperature.

SHRINKAGE POROSITY
MAIN CAUSES: This defect is caused by metal reducing its volume during soldification and an inability to feed shrinkage with more metal before soldification. Hot spots cn also cause shrinkage porosity to be concentrated in a specific zones. See 'SINK'

HEAT CHECKING
MAIN CAUSES: This defect is caused by the surface of the tool steel continually expanding & contracting during use. Excessively cold dies & die flexing accelerate this effect.

LEAKER
MAIN CAUSES: Causes of leaks in castings where pressure tightness is required can be oxide folds and/or inclusions and/or porosity in conjuction with a surface defect which completes the path for a leak. A close analysis of the leaking area may reveal which of the many causes is causing the leak.

DISCOLOURED SURFACE
MAIN CAUSES: Oxide films (dross) and/or residues in the cavity and/or particles in the metal and/or excess die lube can cause the surface to be discoloured. Also it can be caused by a part of the die being too cold causing the casting to have darker regions or 'smears' on the surface.

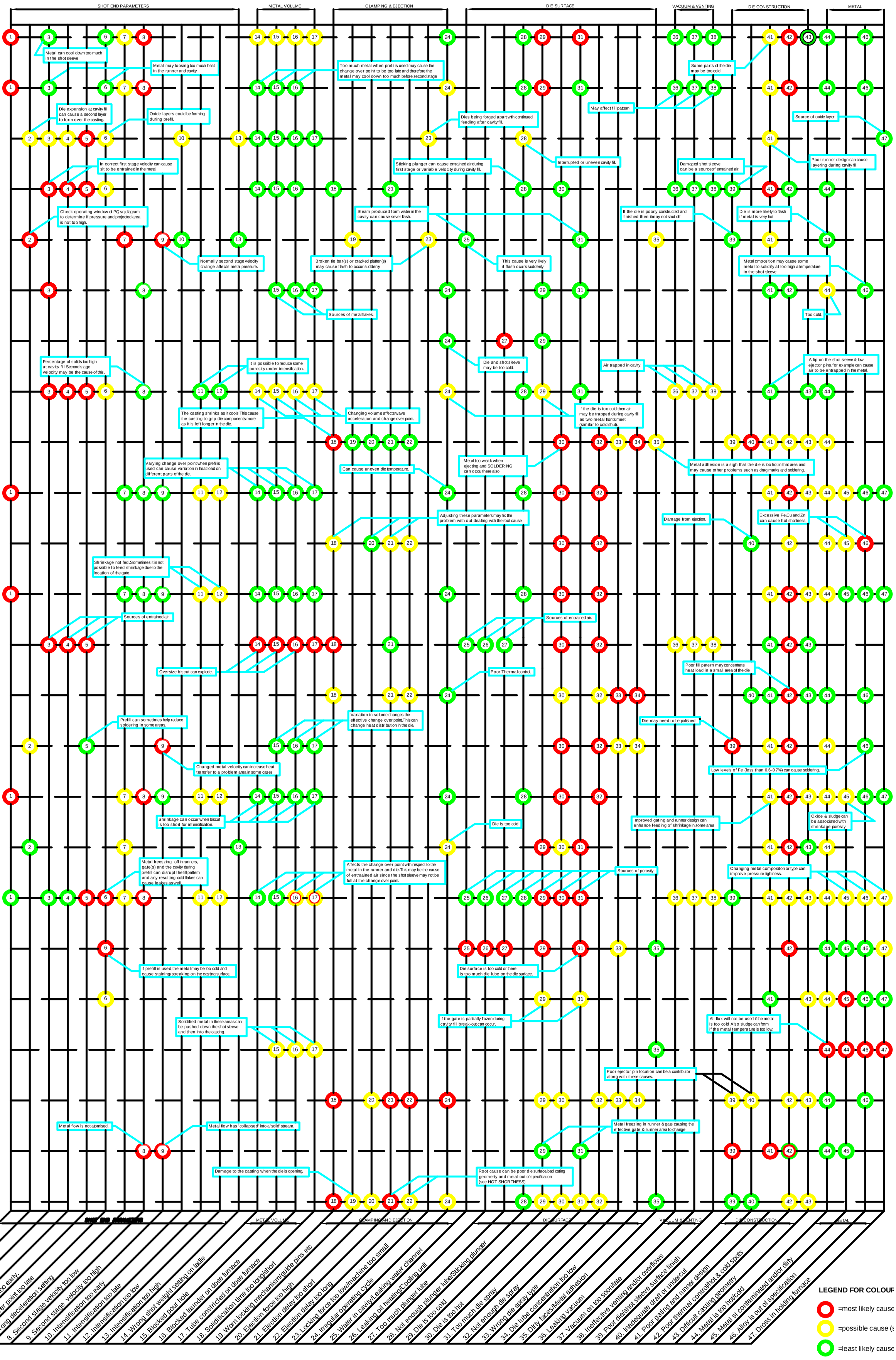
BREAK OUT
MAIN CAUSES: Metal flakes (cold flakes) which get caught in the gate during cavity fill can break out unevenly when the casting is trimmed.

INCLUSIONS
MAIN CAUSES: The main causes of this type of defect are dirty/contaminated metal and/or poor melt handling practice.

EJECTOR DAMAGE
MAIN CAUSES: In broad terms, it can be defined as excessive pressure on the casting surface by the ejector pin (s) during ejection.

EROSION/CAVITATION
MAIN CAUSES: Erosion is caused by direct molten metal impingment of die steel. Cavitation type erosion is caused by turbulance which causes low pressure regions in the flowing metal These low pressure regions cause voids to form which can collapse at the die surface & cause erosion.

CRACKED CASTING
MAIN CAUSES: A crack in the casting can be caused by mechanical damage when the die is opened or when the casting is ejeted. This classification excludes HOT CRACKING & cracking at the surface due to SHRINKAGE POROSITY. Also, this definition excludes HOT SHORTNESS.



SHOT END PARAMETERS
METAL VOLUME
CLAMPING & EJECTION
DIE SURFACE
VACUUM & VENTING
DIE CONSTRUCTION
METAL
Metal can cool down too much in the shot sleeve
Metal may loosing too much heat in the runner and cavity
Too much metal when prefil is used may cause the change over point to be too late and therefore the metal may cool down too much before second stage
Some parts of the die may be too cold.
May affect fill pattern.
Die expansion at cavity fill can cause a second layer to form over the casting.
Oxide layers could be forming during prefill.
Dies being forged apart with continued feeding after cavity fill.
Source of oxide layer
In correct first stage velocity can cause air to be entrained in the metal
Sticking plunger can cause entrained air during first stage or variable velocity during cavity fill.
Interrupted or uneven cavity fill.
Damaged shot sleeve can be a source of entrained air.
Poor runner design can cause layering during cavity fill.
Check operating window of PQ sq diagram to determine if pressure and projected area is not too high.
Steam produced form water in the cavity can cause sever flash.
If the die is poorly constructed and finished then it may not shut off
Die is more likely to flash if metal is very hot.
Normally second stage velocity change affects metal pressure
Broken tie bar(s) or cracked platen(s) may cause flash to occur suddenly.
This cause is very likely if flash occurs suddenly.
Metal composition may cause some metal to solidify at too high a temperature in the shot sleeve.
Sources of metal flakes.
Too cold.
Percentage of solids too high at cavity fill. Second stage velocity may be the cause of this.
It is possible to reduce some porosity under intensification.
Die and shot sleeve may be too cold.
Air trapped in cavity.
A lip on the shot sleeve & low ejector pins, for example can cause air to be entrapped in the metal.
The casting shrinks as it cools. This cause the casting to grip die components more as it is left longer in the die.
Changing volume affects wave acceleration and change over point.
If the die is too cold then air may be trapped during cavity fill as two metal fronts meet (similar to cold shut)
Varying change over point when prefil is used can cause variation in heat load on different parts of the die.
Can cause uneven die temperature.
Metal too weak when ejecting and SOLDERING can occur here also.
Metal adhesion is a sign that the die is too hot in that area and may cause other problems such as drag marks and soldering.
Adjusting these parameters may fix the problem with out dealing with the root cause.
Damage from ejection.
Excessive Fe,Cu and Zn can cause hot shortness.
Shrinkage not fed. Sometimes it is not possible to feed shrinkage due to the location of the gate.
Sources of entrained air.
Oversize biscuit can explode.
Poor Thermal control.
Poor fill pattern may concentrate heat load in a small area of the die.
Prefill can sometimes help reduce soldering in some areas.
Variation in volume changes the effective change over point. This can change heat distribution in the die.
Die may need to be polished.
Changed metal velocity can increase heat transfer to a problem area in some cases.
Low levels of Fe (less than 0.6-0.7%) can cause soldering.
Shrinkage can occur when biscuit is too short for intensification.
Die is too cold.
Improved gating and runner design can enhance feeding of shrinkage in some area.
Oxide & sludge can be associated with shrinkage porosity.
Metal freezing off in runners, gate(s) and the cavity during prefill can disrupt the fill pattern and any resulting cold flakes can cause leakers as well.
Affects the change over point with respect to the metal in the runner and die. This may be the cause of entrained air since the shot sleeve may not be full at the change over point.
Sources of porosity.
Changing metal composition or type can improve pressure tightness.
If prefill is used, the metal may be too cold and cause staining/streaking on the casting surface.
Die surface is too cold or there is too much die lube on the die surface.
Solidified metal in these areas can be pushed down the shot sleeve and then into the casting.
If the gate is partially frozen during cavity fill, break-out can occur.
All flux will not be used if the metal is too cold. Also sludge can form if the metal temperature is too low.
Poor ejector pin location can be a contributor along with these causes.
Metal flow is not atomised.
Metal flow has 'collapsed' into a 'solid' stream.
Metal freezing in runner & gate causing the effective gate & runner area to change.
Damage to the casting when the die is opening.
Root cause can be poor die surface, bad coting geometry and metal out of specification (see HOT SHORTNESS)

POSSIBLE CAUSES

1. Metal pressure too low
2. Metal pressure too high
3. First stage velocity too low
4. First stage velocity too high
5. Change over point too early
6. Change over point too late
7. Wrong deceleration setting
8. Second stage velocity too low
9. Second stage velocity too high
10. Intensification too early
11. Intensification too late
12. Intensification too low
13. Intensification too high
14. Wrong shot weight setting on ladle
15. Blocked pour hole
16. Blocked launder on dose furnace
17. Tube constricted on dose furnace
18. Solidification time too long/short
19. Worn locking mechanism/guide pins etc.
20. Ejection force too high
21. Ejection delay too short
22. Ejection delay too long
23. Locking force too low/machine too small
24. Irregular operating cycle
25. Water in cavity/Leaking water channel
26. Leaking oil heating/Cooling unit
27. Too much plunger lube
28. Not enough plunger lube/Sticking plunger
29. Die is too cold
30. Die is too hot
31. Too much die spray
32. Not enough die spray
33. Wrong die spray type
34. Die lube concentration too low
35. Dirty faces/Metal adhesion
36. Leaking vacuum
37. Vacuum on too soon/late
38. Ineffective venting and/or overflows
39. Poor die/shot sleeve surface finish
40. Inadequate draft or undercut
41. Poor gating and runner design
42. Poor thermal control/hot & cold spots
43. Difficult casting geometry
44. Metal is too hot/cold
45. Metal si contaminated and/or dirty
46. Alloy is out of specification
47. Dross in holding furnace

LEGEND FOR COLOUR

- (red) =most likely cause
- (yellow) =possible cause (
- (green) =least likely cause

Main Reference:"Die Casting Defects"
North American Die Casting Association - NADCA