**D 232**

**COPE SPALL, BOIL SCAB, EROSION SCAB**

All ferrous and copper alloy sand castings.

Massive, rough, irregular layers of excess metal over localized or widespread areas of the surface, generally several mm in thickness and with edges of irregular shape having the appearance of a fractured mold. There may be evidence of multiple crusts of sand, superimposed one upon another, more or less parallel to the mold surface. The projecting layers of metal often appear crevassed by the inclusion of crusts of sand, particularly on the cope surface of the casting. These projections can be removed only by machining or grinding (assuming that the sand inclusions present can be tolerated).

This defect occurs primarily on the cope or drag face of the casting.

**Causes**

The mechanics of formation of this type of defect are as follows:

1. At the cope surface or along vertical or inclined mold walls:

   1.1 - Formation of a low-strength wet condensation zone (sketch 1). Rupture of the dried crust into several pieces due to its restrained expansion (sketch 2). During continued filling of the mold, these pieces of sand crust float and lodge at the cope surface (sketch 3, p 216). Fins (A 112) or rat tails (D 132) may also be present.
1.2 Same as above, but where expansion of the crust is unrestrained at one end (sketch 1, p. 217). This gives rise to two slightly different possibilities. After spalling of the crust (sketch 2):

a. The crust may remain in one piece (sketch 3) and float to the cope surface as the mold fills (sketch 4).

b. The crust spalls and breaks into two or more pieces (sketch 5), again lodging eventually at the cope surface when the mold fills (sketch 6).

See also defect A 112 (veins)
2. At the drag surface of the mold cavity:
The liquid metal causes the rapid formation of a low-strength condensation zone (sketch 1); due to compression restraint of the expanding crust of sand and the low green strength of the latter, the crust separates at the wet layer (especially with high-moisture sands) and is entrained by the liquid metal (sketch 2). The crust eventually lodges at the cope surface as inclusions (E), whereas the spalled face at the drag surface fills with metal (sketch 3), forming a spalling scab.

![Figure 180](image)

**Figure 180**

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S = Scab
E = Sand crust inclusion

![Figure 181](image)

**Figure 181**

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**Schematic Representation of Defects Due to Sand Expansion.**

- **A** = Gate.
- **S** = Spalling of sand crusts at condensation zones.

<table>
<thead>
<tr>
<th>Mold Defect</th>
<th>Casting Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Crust compressed without deformation</td>
<td>No defect</td>
</tr>
<tr>
<td>2 - Crust bulges under effect of compression restraint</td>
<td>Slight depression of the casting surface</td>
</tr>
<tr>
<td>3 - Edge of crust raises, overlapping adjacent surface of the mold</td>
<td>Defect D 132 (rat tail)</td>
</tr>
<tr>
<td>3.1 - Edge of crust raises, permitting infiltration by liquid metal</td>
<td>Defect D 231 (scab)</td>
</tr>
<tr>
<td>4 - Compressed crust fractures without metal infiltration</td>
<td>Defect D 131 (buckle)</td>
</tr>
<tr>
<td>5 - Compressed crust fractures permitting infiltration by liquid metal</td>
<td>Defect D 231 (scab)</td>
</tr>
<tr>
<td>6 - Crust bulges, breaks and falls in pieces</td>
<td>Defect D 232 (spalling scab)</td>
</tr>
<tr>
<td>7 - Crust expands, breaks and falls in one or more layers</td>
<td>Defect D 232 (spalling scab)</td>
</tr>
</tbody>
</table>

(Example following page)
All ferrous and copper-base alloys cast in dry or hardened sand molds or in precision molds.

An extra thickness of metal on the casting surface, flat in shape, having a rough texture and generally with sharp sides and edges. If attached to the casting only at a few points it can generally be removed by means of a chisel. The surface of the casting beneath the scab, in this case, shows a slight depression. If the projection is solidly attached to the casting, the spalled coating having been displaced by the metal stream, one or more inclusions will be present. Such a scab can be eliminated only by grinding (assuming the corresponding inclusions can be tolerated).

Causes
The mold wash, often rich in clay, undergoes contraction when heated whereas the silica sand beneath the coating expands. If there is insufficient adherence of the coating, these two opposed movements can cause it to crack and peel away. As described above, the appearance of the defect will depend upon whether or not the spalled coating is dislodged by the metal stream as the cavity fills.

Remedies
- Use a wash having less thermal contraction.
- Apply a thinner, more uniform wash coating, preferably using two applications to obtain the necessary thickness.
- Use a wash which wets and penetrates the mold surface.
- Use a sand having lower thermal expansion (see D 231 and D 232).