

BART Conversion Tables

10.1. Conversion Tables

Testers have been manufactured in Regina, Canada since 1990 and have undergone ISO 9001:2000 compliant quality management since 2001. As improvements have been made these are reflected in the "Standard *Methods for the Application of BART testers in Environmental Investigations of Microbiological Activities*" from the first edition, 2009, through to the second edition in 2010 through to the release of the third edition in 2013. Major changes are ongoing and have involved such steps as the revised recognition of the types of reactions and activities that occurred within the various types of testers. These have at least been in part the result of users who reported difficulty with the declaration of activities and reactions within the tester. Initially a numeric system was applied to differentiate these events (Practical Manual of Groundwater Microbiology, first edition, D. Roy Cullimore published by CRC Press, 1993). It became realised between 1990 and 1997 that the use of a number designation was causing confusion and this was changed to a two letter descriptor of the reaction or activity. These new reaction codes were published in "*Microbiology of Well Biofouling*" by Roy Cullimore published by CRC Press, 1999. No conversion tables were made available at that time and some BART users are still employing the original numeric code system and have not switched to the two-letter code. The following tables allow the conversion of numeric to two-letter codes for the reactions and activities within the testers. They are listed below in order: (Table 10.1., IRB-BART; Table 10.2., SLYM-BART; Table 10.3., SRB- BART; Table 10.4., FLOR- BART; Table 10.5., formerly TAB- and now HAB- tester). The other testers were introduced after 1993 and have used only the two-letter reaction coding system presented by Cullimore (1999). Since the first edition of the practical manual of Groundwater Microbiology and became a publishers best seller as a scientific book, a second edition was published in 2008 and includes many changes and improvements. This chapter addresses the changes in the recognition of reactions sine the

first edition was published in 1993 and the second edition in 2008. Conversion tables are presented that summarise the major changes. For this chapter each table is presented in turn followed by a commentary of the changes and the reasons to improve clarity for the Bart user.

Table 10.1 Conversion table for reaction numbers to two letter codes for IRB- tester

1993 Reaction number	1999 two-letter code	Comments
1	BG	A
2	BR	B
3	BG	C
4	BC	D
5	FO	E
6	BR	F
7	RC	G
8	GC	H
9	GC	I
10	BL	J
13	ND	K

Comments: A, reaction 1 was a “brown basal swirl” but it was found to stabilize into a brown gel and so was given BG coding; B, reaction 2 was brown ring over a clear solution that was redesignated as brown ring, BR and references to the clarity of the solution was not considered significant for the BR reaction (see also reactions 6 and 7); C, reaction 3 was “brown ring and gel” which has been simplified to basal gel (BG) which may be either ferric-brown or dark green and has been frequently associated with ochres; D, reaction 4 “brown cloudy” now becomes the BC reaction with no change in definition; E, reaction 5 “gas bubbles” has been clarified to simply the observation of a foam ring (FO) which occurs only when the gas bubbles have risen to form a foam ring at least 75% of the way round the floating BART ball; F, reaction 6 “brown

ring over yellow solution has been reclassified as a brown ring (BR); G, reaction 7 “brown ring red” has been reclassified as red cloudy (RC) with the brown ring (BR) being given separate code status; H, reaction 8 “green cloudy” remains as GC regardless of turbidity in the culturing solution; I, reaction 9 reverts to a GC reaction code since cloudiness in the sample being cultured (turbidity) is no longer recognized as a prime factor; J, reaction 10 defined as “black deposits” has been redefined as black liquid (BL reaction code); K, reaction 13 is an undescribed negative reaction in which none of the recognized reactions for the IRB-tester have occurred.

Table 10.2 Conversion table for reaction numbers to two letter codes for the SLYM- tester

1993 Reaction number	1999 two-letter code	Comments
1	DS	A
2	CP	B
3	SR	C
4	DS	D
5	CL	E
5	CL-PB or CL-GY	F
6	BL	G
13	FO	H

Comments: A, reaction 1 is a slimy basal swirl which modifies commonly to a dense slime(DS) since the gel commonly destabilises during growth; B, reaction 2 is “plate-like rings and clouds now refined to cloudy layered plates (CP) which occur during the early phases of growth as either fluffy clouds or thin lateral plates which generally float up the tester towards the ball; C, reaction 3 is “slimy ring” which becomes SR and is normally white or beige but can occasionally be other colors (e.g. yellow, violet, orange, red and brown); D, reaction 4 is a “slimy ring and gel” but now refers to a dense slimy gel (DS) with the slime ring being recognized separately as SR with commonly the DS forming and concentrating in the lower half of the tester; E, reaction 5 is a “white cloudy” which has been found to be a dominant reaction and so is retained as CL (cloudy) reaction; F, reaction 5 also has U.V. fluorescent pale blue or greenish yellow colors that

indicate the special nature of these reactions as CL-PB or CL-GY depend upon the dominant pseudomonad species in the sample; G, reaction 6 relates to the “black deposits” which have now been redefined as “black liquid (BL) and may be caused by either reduced organic carbonaceous daughter products or possibly iron carbonates; H is reaction 13 or “fuzzy ring” in which there was evidence of fungal growth particularly around the ball to form a mycelium. In this event there could also be the generation of a gas bubble foam (FO) around the ball. Most commonly it is a gas filled foam that forms but if fungi dominate then growth ring around the ball would no contain gas bubbles and may appear “furry”.

Table 10.3 Conversion table for reaction numbers to two letter codes for SRB- testers

1993 Reaction number	1999 two-letter code	Comments
1	BB	A
2	BT	B
3	BA*	C
X	CL**	D

Comment: A, reaction 1 is a “black deposit” which is now defined as black base (BB) in which the base of the tester goes jet black along with the bottom 2 to 4mm of the sides of the ball; B, reaction “black ring” has been reclassified as black top (BT) since the sulfide is generated in the biomass growing around the lower half of the ball (initially) as small jet black specks that then coalesce into a jet black band; C is reaction 3 which is described as “black ring and deposit” and has been described as black all (BA) but this reaction (*) within commonly follows BB or BT and so is a secondary reaction (in the event of the tester being BA when observed then the first reaction defaults to BB; D, reaction X refers to “partial or complete clouding with no sign of any black deposits” is a term that effectively indicates that no SRB (sulfide producing bacteria) are active and yet there was considerable bacterial activity (hence clouding, CL**) are present, it should be noted that CL designated as any form of growth or activity not involving the generation of jet black deposits and is a negative for SRB (**). Note that technically the SRB=

tester should be redefined as the SPB- tester since H₂S may come from sulfates (BB) or sulfur-rich organics (BT).

Table 10.4 Conversion table for reaction numbers to two letter codes for the FLOR- tester

1993 Reaction number	1999 two-letter code	Comments
1	CL*	A
2	CL-GY	B
2	CL-PB	C
3	**	D

Comment: A, reaction 1 was defined as “cloudy” and is now classified as CL but the asterisk (*) means that this is not a positive detection of either of the groups of fluorescent pseudomonad bacteria; B reaction 2 to the left of figure 47, p.310 (Cullimore 1993) relates to “green-yellow fluorescence” and has been reclassified as CL-GY; C, reaction 2 to the right of figure 47, p.310 (Cullimore 1993) relates to “pale blue fluorescence” and has been reclassified as CL-PB; D reaction defined as “clear” is not recognized as a reaction other than that the clouding culturing fluids clear following fluorescence and this should be considered a negative (**) unless preceded by fluorescence in the case of fluorescing bacteria.

Table 10.5 Conversion table for reaction numbers to two letter codes for the HAB- tester

1993 Reaction number	1999 two-letter code	Comments
Bleached up	UP	A
Not recognized	DO	B

Comment: A, in the first edition Cullimore (1993) did not clarify the different reaction types in the (then TAB- BART but the one described in the text related to an UP reaction only and this is

now the standard for aerobic heterotrophically active bacteria; B, no reaction was described by Cullimore in 1999 for a descending (DO) reaction in which the bleaching (reduction) usually began just under the ball sometimes with the BART ball turning from pale blue to clear, this is now the DO reaction which is common for facultative anaerobes and anaerobes growing under reductive conditions.