EVALUATING THE AVALUATOR AVALANCHE ACCIDENT PREVENTION CARD 2.0

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ABSTRACT: The Avaluator Avalanche Accident Prevention Card (Haegeli & McCammon, 2006), consisting of the Trip Planner and Obvious Clues, was marketed by the Canadian Avalanche Association/Center (CAA/C) as a decision support tool for prevention of avalanche accidents. For Obvious Clues, users simply added up the number of obvious clues (e.g., loading, terrain trap) and the Avaluator provided them with the percentage of accidents prevented and travel recommendations. However, the Avaluator's prevention values differed widely from the values reported by Haegeli and McCammon previously (Uttl et al., 2007, 2008) and were not replicated by several independent studies (Uttl et al., 2008, 2009; Floyer, 2008). Moreover, Haegeli and McCammon refused all requests to produce the data behind their claims and for clarification of their methodology (Uttl et al., 2008, 2009). The CAA/C advised Avalanche Safety Training instructors not to use the Obvious Clues prevention values (Calgary Herald, April 20, 2009); included new disclaimers absolving the authors and CAA/C of any responsibility for any deaths, injuries and other damages caused by the Avaluator; and eventually, published the Avaluator 2.0 (Haegeli, 2010) with the Obvious Clues replaced by “Slope Evaluation” and McCammon no longer appearing as one of the authors. We examined whether the new Slope Evaluation is likely to prevent more or fewer accidents than the original Avaluator. Our analysis of over 1,000 North American accidents suggest that the Avaluator 2.0 suffers from many of the same problems that plagued the original Avaluator. We discuss implications of our findings for avalanche safety training programs.

KEYWORDS: Avaluator Avalanche Accident Prevention Card, Accident Prevention, Risk reduction tools, Risk, Decision Making

1. INTRODUCTION

In the 2002-03 winter season, avalanche accidents in Canada took 29 lives, principally because of two accidents that each resulted in seven deaths. In response, Parks Canada as well as the British Columbia government commissioned reviews with the goal of improving public avalanche awareness and avalanche safety training programs. The Parks Canada review noted that in Europe rule-based decision making tools (e.g., Munter's 3x3) were gaining popularity and recommended the development of “made-in-Canada” decision tools “to better equip recreational backcountry users to evaluate and to reduce avalanche risks” (O'Gorman et al., 2003).

At about the same time, McCammon and Haegeli (2004, 2005) examined the performance of several European decision making tools (Munter's Reduction Method, Nivo Test, Stop-or-Go, Snow Card) as well as McCammon's Obvious Clues method (McCammon, 2002, 2004) against 33 years of avalanche accident data from the United States. Based on their flawed analyses, they concluded that the Obvious Clues method was superior to all of the European tools reviewed.

Shortly thereafter, the Obvious Clues method -- developed in United States by McCammon (2002, 2004) and based on solely US accidents -- was incorporated into the new “made-in-Canada” Avaluator Avalanche Accident Prevention Card authored by Haegeli and McCammon (2006) and published by Canadian Avalanche Association (CAA). However, a few years later, in March 2010, the Canadian Avalanche Centre published the new Avaluator v2.0 with the Obvious Clues removed and McCammon no longer appearing with Haegeli as co-author.

In this paper, we first briefly review both the original and the new Avaluator and then examine whether the new Avaluator prevents more or fewer accidents than the original Avaluator.

1.1 *Original Avaluator: The Rise and Fall of McCammon's Obvious Clues*

The original Avaluator (Haegeli & McCammon, 2006) consists of the Trip Planner and Obvious Clues. The Trip Planner is used to assess the suitability of a particular terrain given the current avalanche danger rating (low, moderate, considerable, high, extreme) and the terrain rating (simple, challenging, complex). It provides the user with one of the following recommendations:

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proceed with caution, proceed with extra caution, and not recommended.

The Obvious Clues informs users whether a particular slope is safe to cross. The Obvious Clues is a simple checklist of seven signs of avalanche danger: Rating, Avalanches, Thaw, Loading, Path, and Trap (see Table 1 for definitions of each of these clues). The user adds up the number of Obvious Clues present and the Avaluator makes one of the three recommendations: proceed with normal caution (2 or fewer clues), proceed with extra caution (3 or 4 clues), and not recommended (5 or more clues). Moreover, the Avaluator shows the users the percentage of historical accidents prevented if users had limited their travel to slopes with a given number of clues. For example, if users had limited themselves to slopes with 4 or fewer clues, the Avaluator states that 77% of historical accidents would have been prevented. Haegeli and McCammon (2006) call this “a prevention value”.

However, a review of the methodology behind the Avaluator by Uttl, Uttl, & Henry (2008; see also Uttl, Henry, & Uttl, 2008) revealed numerous methodological problems that invalidated the prevention values published in the Avaluator. First, the prevention values published in the Avaluator differ widely from the prevention values reported by McCammon elsewhere (McCammon, 2002, 2004). Second, the prevention values published in the Avaluator are based on only 252 accident that remained in the accident data set after the authors inappropriately deleted 1,148 accidents with one or more missing values (i.e., if an accident record did not provide relevant information to establish the presence or absence of one or more of the obvious clues, Haegeli and McCammon simply deleted it). Third, Haegeli and McCammon repeatedly refused to clarify their methodology and also refused to allow access to their data for the limited purpose of verifying their claims (Uttl, Uttl, & Henry, 2008).

Uttl, Henry, and Uttl (2008) attempted to replicate the Obvious Clues prevention values using several independent sets of avalanche accident reports. Using the US accident records drawn from the same sources as those used by Haegeli and McCammon (2006), Uttl et al. found that the prevention value of limiting one's travel to 4 or fewer clues was only 18% rather than the 77% reported by Haegeli and McCammon (2006) in the Avaluator.

The difference between the prevention values obtained by Uttl, Henry, and Uttl (2008) and those reported in the Avaluator can be traced to Haegeli and McCammon (2006) inappropriately treating the missing data as missing at random (Uttl, Uttl, & Henry, 2008; Little & Rubin, 1987; Schaffer & Graham, 2002). In contrast, Uttl, Uttl, and Henry (2008) and Uttl, Henry, and Uttl (2008) demonstrated that the missing values mean absence of the clues for at least three of the seven clues where external data were available to determine their presence or absence (Thaw, Unstable Snow, Rating). Consistent with these analyses, Uttl and Kisinger (2009, 2010) later showed that eyewitnesses are far more likely to report the presence of present conditions and behaviors (e.g., snow) than the absence of absent conditions and behavior (e.g., absence of snow). In combination, the external data as well as data reported by Uttl and Kisinger (2009, 2010) indicate that the missing values occurred because the obvious clues were absent rather than due to some purely random mechanism as unwittingly assumed by Haegeli and McCammon (2006).

The low prevention values of the Avaluator's Obvious Clues reported by Uttl, Henry and Uttl (2008) were later replicated by Floyer (2008) who was hired to attempt to replicate the prevention values published in the Avaluator by the Canadian Avalanche Centre, the publisher of the Avaluator.

Uttl, Kisinger, Kibreab, and Uttl (2009) were the first to examine the Obvious Clues prevention values in Canadian accidents. They reported that the prevention value of limiting one's travel to 4 or fewer clues was only 9% in Canadian accidents. Gauthier (2010) substantially replicated Uttl et al.'s (2009) findings and reported that (assuming missing values indicate absence of the obvious clues) the prevention value of 4 or fewer clues in Canadian accidents was only 21.1%. Although Gauthier's (2010) references include Uttl et al.'s (2009) paper as well as several other papers directly relevant to Gauthier's study (Uttl, Uttl, & Henry, 2008; Uttl, Henry, & Uttl, 2008; Uttl & Kisinger, 2009), Gauthier was either not familiar with or chose to ignore the content of the referenced papers. To illustrate, he incorrectly claimed that he was the first to examine the prevention values in Canadian accidents and, given his lack of awareness, he failed to compare his results to Uttl et al.'s (2009) prior findings. Similarly, Gauthier did not mention that the missingness mechanism was already investigated extensively by Uttl, Henry and Uttl (2008) and Uttl and Kissinger (2009, 2010) and that the evidence strongly indicates that the principal mechanism behind the missing values is eyewitnesses' failure to report absence of conditions and behaviors. Having failed to familiarize himself with these prior findings, he incorrectly claimed that it was in fact

Table 1. Comparison of the original Avaluator's Obvious Clues and the Avaluator's v2.0 Slope Evaluation.

Avaluator's Obvious Clues	Points	Avaluator's v2.0 Slope Evaluation	Points
OBVIOUS CLUES		**AVALANCHE CONDITIONS**	
Rating Is the danger rating considerable or higher?	+1	**Regional Danger Rating** Is the avalanche danger rating "Considerable" or higher?	+1
		Persistent Avalanche Problem Is there a persistent or deep persistent slab problem in the snowpack?	+1
Avalanches Are there signs of slab avalanche activity in the area within the last 48 hours?	+1	**Slab avalanches** Are there signs of slab avalanches in the area from today or yesterday?	+1
Unstable Snow Are there signs of unstable snow, such as whumpfing, cracking or hollow sounds?	+1	**Signs of Instability** Are there signs of snowpack instability including whumpfs, shooting cracks or drum-like sounds?	+1
Loading Was there significant loading by snow, wind or rain in the area within the last 48 hours?	+1	**Recent Loading** Has there been loading within the past 48 hours including roughly 30 cm of new snow or more, significant transport or rain?	+1
Thaw Instability Has there been recent significant melting of the snow surface by sun, rain or warm air?	+1	**Critical Warming** Has there been a recent rapid rise in temperature to near 0 C, or is the upper snowpack wet due to strong sun, above-freezing air temperatures or rain?	+1
		TERRAIN CHARACTERISTICS	
		Slope Steepness Is the slope steepness between 30 and 35 degrees?	+1
		Slope Steepness Is the slope steeper than 35 degrees?	+2
Terrain Trap Are there gullies, trees or cliffs that would increase the consequences of being caught?	+1	**Terrain Traps** Are there gullies, trees or cliffs that increase the consequences of being caught in an avalanche?	+1
		Slope Shape Is the slope convex or unsupported?	+1
Path Are you in obvious avalanche path or starting zone?	+1	**Forrest Density** Is the slope in the alpine, in a sparsely treed area or in open forest (cut-block, burn, wide-spaced glades)?	+1
TRAVEL RECOMMENDATIONS		**TRAVEL RECOMMENDATIONS**	
"Not Recommended"	> 4	"Not Recommended"	> 6
"Extra Caution"	3-4	"Extra Caution"	3-6 if TCS 1-2 4-6 if TCS 3 5-6 if TCS 4-5
"Normal Caution"	0-2	"Caution"	1-2 if TCS 1-2 3 if TCS 3 4 if TCS 4

impossible to determine the mechanism behind the missing values; he wrote: “Unfortunately, as we do not have any sound means to determine the actual clue prevalence...”. In turn, he concluded that “Until the true clue prevalence is known, any interpretations [of what the missing values mean] are speculative.

This has been precisely our point: Haegeli, McCammon, and CAA/CAC should not be sending thousands of naive recreationists to the winter backcountry and asking them to make decisions about their personal survival based on what Gauthier (2010) calls [Haegeli and McCammon's] “speculation” that the missing data are missing at random. Haegeli and McCammon (2006) did not even speculate; they were simply completely unaware that deleting 82% of the data may be a problem.

Having failed to review the relevant prior scholarship demonstrating that the missing data are not missing at random, Gauthier (2010) continued making a variety of contradictory statements about what is the most appropriate assumption regarding the meaning of missing values. To illustrate, on page 494, he states that the assumption that missing values in fact mean that the clues were present is “an unrealistic assumption” but on page 495 he claims that this same assumption “may be the most appropriate”. Then a few paragraphs later, Gauthier (2010) claims that “missing at random may be the most reasonable”. Confusing?

All evidence that the missing values mean primarily absence of the obvious clues aside, Gauthier (2010) correctly concluded that his results showed that “the 'true' prevention value is between 80.2% and 21.1% for that [4 clues or fewer] threshold.” (p. 494-495). Clearly, telling AST students and Avaluator users that if they limit themselves to 4 or fewer clues they will avoid 77% of accidents is hugely misleading and gives them a false sense of confidence in slope stability. Not surprisingly, the trend analysis of Canadian avalanche accidents showed that the Avaluator did not reduce the number of fatal accidents in Canada but that the number of avalanche accidents in fact increased following its introduction (Uttl, Kibreab, Kisinger, & Uttl, 2009).

Despite his failure to familiarize himself with prior research and acknowledge the contributions of others, Gauthier (2010) should be applauded for recognizing that “only with a complete dataset can meaningful accident prevention values be calculated, after which the appropriate clue threshold-based travel recommendations may be determined.” The logical conclusion of his view is that one ought not to send thousands of recreationists to the winter backcountry based on speculations and incomplete datasets as Haegeli, McCammon (2006), the CAA and the CAC have done. Incidentally, this is what we have been saying since 2008 (Uttl, Uttl, & Henry, 2008; Uttl, Henry, & Uttl, 2008).

In response to these criticisms, the CAC first defended the Avaluator's Obvious Clues as the “best tool” available (Uttl, Smibert, Morin, Wells, Uttl, & Hamper, 2010) even though it already had its own investigative report authored by Floyer (2008) showing that the prevention values were not replicable. Next, it advised AST instructors to tell students to disregard the prevention values (Uttl, Smibert, Morin, et al., 2010). Next, worried about lawsuits and liabilities, it reprinted the Avaluator (2009, 3rd printing, January) with two new disclaimers. The first one states that the Obvious Clues method is not suitable “for any particular purpose, use or application” (e.g., not suitable for assessing slopes) and the second states that the CAC is not liable for any damages, injuries, and deaths caused by its use (Uttl, Smibert, Morin, et al., 2010).

Finally, in March 2010, the CAC published the new Avaluator v2.0 (Haegeli, 2010) with the Obvious Clues and discredited prevention values removed all together. The new Avaluator was authored only by Haegeli with McCammon no longer appearing as a co-author. Unfortunately, as of August 8, 2012, Mountain Equipment Co-op still offers the discredited and flawed original Avaluator (Haegeli & McCammon, 2006) for sale to unsuspecting winter recreationists.

1.2 *New Avaluator 2.0: Welcome the Warning Signs*

In March 2010, Haegeli published the new Avaluator – Avaluator Avalanche Accident Prevention Card v2.0. As was the case with the original Avaluator, the Avaluator 2.0 consists of the original Trip Planner (i.e., based on the same flawed data and inappropriate exclusion of records with missing values) and a new slope evaluation tool called “Slope Evaluation”. The Slope Evaluation tool replaced McCammon's discredited Obvious Clues.

However, the Slope Evaluation tool is just like the Obvious Clues except that it includes three new clues (Slope Steepness, Slope Shape, Persistent Avalanche Problem). Clues are called “warning signs”; one of the warning sings (Slope Steepness) is weighted by the angle of the slope (1 point for slopes 30 to 35 degrees and 2 points

for slopes over 35 degrees). The warning signs are split into two separate checklists (Avalanche Conditions and Terrain Characteristics, each with its own separate score), and prevention values are no longer provided.

Table 1 directly compares the Slope Evaluation to the Obvious Clues. The Slope Evaluation includes all seven of the Obvious Clues (listed under somewhat different names) plus the three new clues that were obviously missing from the Obvious Clues method (Uttl & Uttl, 2009). Haegeli (2010) now acknowledges that the "slope steepness is the single most important factor for assessing the seriousness of avalanche terrain" (p.18).

Similarly to the Obvious Clues, the Slope Evaluation tool provides one of three recommendations for crossing slopes: Caution, Extra Caution, and Not recommended. Table 2 shows the cut-offs for the recommendations based on the Avalanche Condition Score (ACS) and Terrain Characteristics Score (TCS). However, an examination of the Avaluator 2.0 warning signs indicates that it is impossible to get an ACS score equal to zero because all slopes will be either open (scoring 1 on Forest Density), or having some trees (scoring 1 on Terrain Traps). As Table 2 shows, the Not recommended cut-off requires more than 6 warning signs on the two checklists combined for all TCS except the impossible TCS condition of zero. Accordingly, the two checklists can be collapsed into one Obvious Clues-like checklist where the user adds up the points and if the total number of points is greater than 6, crossing the slope is not recommended.

Table 2. Avaluator 2.0 Slope Evaluation Travel Recommendations based on Avalanche Condition Score (ACS) and Terrain Characteristics Score (TCS).

	TCS					
ACS	0	1	2	3	4	5
6	6	7	8	9	10	11
5	5	6	7	8	9	10
4	4	5	6	7	8	9
3	3	4	5	6	7	8
2	2	3	4	5	6	7
1	1	2	3	4	5	6
0	0	1	2	3	4	5

What is the basis for the behavioral recommendations of the Slope Evaluation tool? Haegeli (2010) explains the basis for the recommendations as follows: "Every winter, mountain guides and avalanche technicians make thousands of decisions about when and where to travel in avalanche terrain. In developing the [new] Avaluator, I tried to capture the expertise of this professional community, and present it in a way that makes it more accessible to you." There is no reference nor any other detail on how the expertise of the professional community was captured and how that expertise was translated to the behavioral recommendations printed in the Avaluator v2.0.

Thus, the method used to develop the Avaluator's v2.0 behavioral recommendation is unknown, and therefore, the behavioral recommendations are not replicable and not verifiable.

1.3 *Objectives*

The objective of the present study was to examine whether the new Slope Evaluation is likely to prevent more or fewer accidents than the original Avaluator's Obvious Clues.

2. METHOD

We examined over 1,000 recreational avalanche accidents published in *The Snowy Torrents* (Williams, 1975; Williams & Armstrong, 1984; Logan & Atkins, 1996), *Avalanche Accidents in Canada* (Stethem & Schaerer, 1979, 1980, 1987; Jamieson & Geldsetzer, 1996), and Avalanche Center database (www.avalanche-center.org) from 1998 to 2009.

Each avalanche accident record was coded for the presence or absence of various avalanche accident factors/characteristics (e.g., the presence vs. absence of the Obvious Clues) using a 5-point scale: Yes (factor is present), Weak Yes (factor is probably present), Unknown (presence or absence cannot be established), Weak No (Factor is probably absent), No (factor is absent) (see Uttl, Henry, & Uttl, 2008).

3. RESULTS

Figure 1 shows the distribution of the Warning Signs and associated prevention values under the two different assumptions about the meaning of missing values: (1) missing values means the absence of signs (red, solid line), and (2) the missing values means the absence of signs for the obvious clues/signs, but the missing values are distributed the same way as the observed clues

for the non-obvious clues (e.g., slope angle) (i.e., missing at random; blue dotted line).

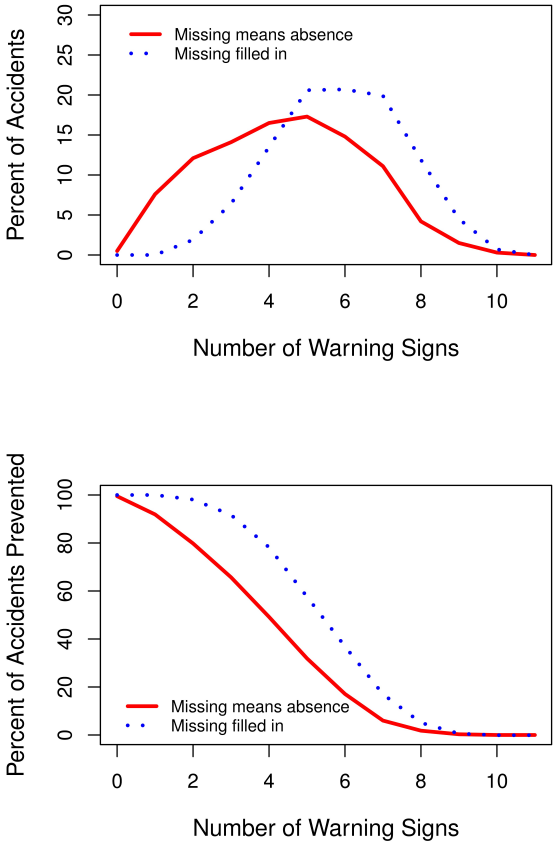

Figure 1. The distribution of Warning Signs (top panel) and associated prevention values (bottom panel) under two different assumptions: (1) missing values mean absence of warning signs (Missing means absence) and (2) missing values for non-obvious clues/signs are missing at random (and are filled in randomly using probabilities from accidents with known values) (Missing filled in).

The prevention value of limiting one's travel to 6 or fewer signs is only 17% under the missing means absence assumption and only 35% when the missing values for the non-obvious clues are filled in randomly using their distribution in accidents where relevant information was provided.

4. DISCUSSION

From an armchair's perspective, the Avaluator's v2.0 Slope Evaluation is an improvement relative to the original Avaluator's Obvious Clues. The “most important terrain clue” (Haegeli, 2010), slope angle, has finally been included among the “danger signs” alongside two additional important clues: presence of weak layers and slope shape. Yet, the Avaluator v2.0 continues to ignore other important clues/signs of increased risk, for example, the amount of new snow. The new Slope Evaluation tool makes no distinction between 30 vs. 70 cm of new snow whereas at least some other tools do (e.g., Nivo Test).

From the prevention values perspective, the Avaluator 's v2.0 Slope Evaluation suffers from the same limitations that plague the original Avaluator's Obvious Clues: the prevention values are as low as 17% under the assumption that missing values mean absence and only 35% when missing values for the non-obvious clues are filled in by randomly sampling from the distribution of the clues obtained in accidents with enough information. Moreover, the prevention values tell us nothing about how useful the tool is in preventing avalanche accidents while facilitating accident-free trips (Uttl, Taylor, & Uttl, 2010)

The new Avaluator v2.0 no longer provides the prevention values for Slope Evaluation but it does provide behavioral recommendations (e.g., recommended/not recommended or go/no-go). Users are advised that any slopes with more than 6 signs/points are not recommended. However, it remains unclear how Haegeli (2010) arrived to these recommendations. The Avaluator v2.0 itself merely states that Haegeli “tried to capture the expertise of this [mountain guides and avalanche technicians] professional community.” (p. 1). Haegeli and Atkins's (2010) ISSW extended abstract directs the reader to contact Haegeli “to receive a copy of the accepted manuscript” but nearly two years later this copy is not yet available (P. Haegeli, personal communication, August 9, 2012) .

Haegeli and McCammon (2006) never informed the original Avaluator's Obvious Clues method users that their tool is based on only 252 accidents after they eliminated all accidents with missing values from their dataset. They did not even consider the implication that missing values have on the analyses of accident records. They never told users that the 77% prevention values associated with limiting one's travel to four or fewer clues was based on what Gauthier (2010) calls “speculation” that missing values are missing at random.

It was only after Uttl, Uttl, and Henry (2008) and Uttl, Henry, & Uttl (2008) pointed out that how one treats missing values has a huge impact on the prevention values that CAA/CAC became

concerned about the original Avaluator's Obvious Clues travel recommendations. Following Uttl and his colleagues criticism, Floyer (2008) replicated Uttl, Henry, and Uttl's (2008) earlier findings and acknowledged that the treatment of the missing values had a huge impact on the prevention values. Gauthier (2010) replicated Uttl, Kisinger, Kibreab, and Uttl's (2009) previous research showing that the treatment of missing values have huge impact on the prevention values but concluded (incorrectly) that there were no sound means to examine the mechanisms behind the missing values and called any interpretations of missing values "speculative".

Thus, in Gauthier's (2010) terms the original Avaluator's Obvious Clues were based on Haegeli and McCammon's (2006) "speculation" that missing values were missing at random, which is now known to be false (Uttl, Henry, & Uttl, 2008; Uttl, Uttl,& Henry, 2008; Uttl & Kisinger, 2009, 2010). Not surprisingly, the Obvious Clues, prevention values, and McCammon are no longer included in the new Avaluator v2.0 (Heageli, 2010).

Disappointingly, the science behind the new Avaluator v2.0 is unknown, as unknown as the 252 accidents that Haegeli and McCammon used to develop the original Avaluator (Haegeli and McCammon repeatedly refused to disclose details of their methodology and identity of the 252 accidents, see Uttl, Uttl, & Henry, 2008; Uttl, Smibert, Morin, et al., 2010). At the present, the Avaluator's v2.0 Slope Evaluation travel recommendations are unreplicable and unverifiable.

A question arises: Should one market the new Avaluator v2.0 card as an "Avalanche Accident Prevention Card" when there is no known scientific basis for its behavioral recommendations? Is it ethical to market it, claim it prevents accidents, and having no evidence that it actually does? Is it ethical to teach it to students in Avalanche Safety Training courses without disclosing to them that it is based on unknown, and therefore not replicable methodology and findings?

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