



# Fentanyl Testing Strips Usage and Perceptions: A Survey Analysis

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## ABSTRACT

**Background:** Fentanyl testing strips (FTS) were decriminalized in Tennessee in 2022, and since then have become a widely used tool for harm reduction efforts across the state. Considering that fentanyl has almost entirely replaced heroin and other opioids in the drug supply, we sought to explore whether FTS were in fact an impactful harm reduction strategy. This study examines the usage patterns and perceptions related to Fentanyl Testing Strips (FTS) among individuals with a history of drug use in both urban and rural contexts.

**Methods:** The survey collected data on FTS usage, reasons for usage (of both substances and FTS), perceptions of FTS, and the perceptions of the impact of drug use on the individuals and their communities.

**Results:** 88.9% of respondents reported a willingness to use FTS, and those reported needing an average of three per day with 83% willing to wait at least five minutes for the result. 87.8% reported that they would take additional precautions to avoid overdose in response to a positive FTS result, with such behaviors including not using or discarding the fentanyl-positive substance, acquiring naloxone, not using alone or calling a friend, or the modification of dose, speed, and/or route of ingestion. 100% of those that used amphetamines daily (including methamphetamine), whether with or without opioids, reported a willingness to take additional precautions.

**Conclusion:** The results shed light on the importance of harm reduction strategies and the potential role of FTS in reducing the risks associated with drug use, particularly for those that use amphetamines.

**Keywords:** Fentanyl, Testing Strips, Harm Reduction, Substance Use Disorder, Survey Analysis, Amphetamine

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## INTRODUCTION

The polysubstance overdose crisis continues in the United States, pulling down the country's overall life expectancy by 0.67 years due to its significant contribution to mortality, especially among those aged 18-45 (Hébert & Hill, 2024). This is largely driven by the emergence of illicitly-manufactured fentanyl and other synthetic opioid analogues (Tomassoni et al., 2017; Wilson et al., 2020; Ahmad, 2023). Fentanyl (and its analogues, such as carfentanil) is most often encountered in the illicit market in the form of counterfeit pills or powders masquerading as heroin, conventional prescription opioids or other substances, frequently in combination with other adulterants including stimulants like methamphetamine. The presence of fentanyl may or may not be made known to the purchaser of the drugs (Commission on Combating Synthetic Opioid Trafficking, 2022; Frank & Pollack, 2017; Friedman and Shover, 2023; Stogner, 2014).

Fentanyl test strips (FTS), a user-friendly, self-administered tool that checks for the presence of fentanyl, is a low-barrier, cost-effective method of harm reduction (Bardwell & Kerr, 2018; Weicker et al., 2020). FTS allows individuals to test drug samples for fentanyl, with the goal of reducing the likelihood of unintentional intake of fentanyl and promoting safer drug use behaviors (Pu et al., 2021). Research indicates that when provided, FTS are extensively used and linked with protective alterations in drug use behavior, such as reducing usage, consuming with others, or ensuring naloxone is easily accessible (Krieger et al., 2018).

The Tennessee Department of Mental Health and Substance Abuse Services, having distributed 126,000 FTS in the first year of

decriminalization in 2022, collected voluntary data from people who used FTS. They found that 85% of respondents reported at least one positive behavior change (such as reducing the dose they intended to take, acquiring naloxone, or changing the method of drug use (i.e., snorting instead of injecting), which is much higher than the 43% found in a previous and independent study conducted in North Carolina (Peiper et al., 2019).

Conversely, other studies have found that when people who use drugs (PWUD) perceive that fentanyl is already widespread in the drug supply, they were less interested in using FTS (Glick, 2019, Goldman et al., 2019), and high concentrations of illicit stimulants and other adulterants have been found to increase the chances of a false positive result (Lockwood et al., 2021). While FTS have shown potential in promoting safer drug use behaviors, questions remain about their effectiveness in a market saturated with fentanyl (Karamouzian et al., 2018, Bardwell & Kerr, 2018, Peiper et al., 2019).

Given this variation in responses among participants across different studies on the impact of FTS, and that there are different "drug cultures" surrounding different substances, with "certain shared values, beliefs, customs, and traditions, [as well as] its own rituals and behaviors that evolve over time," (Center for Substance Abuse Treatment, 2014), it can be deduced that PWUD would have different attitudes toward FTS based on which substances they typically consume. Finding out these differences in attitudes toward FTS would be of great utility to harm reduction programs, treatment providers, and policymakers in determining the most effective ways of using FTS.

The focus of this study was to explore participants' perception of and willingness to use FTS based on drug consumption habits, as well as safety perceptions regarding overdoses among this population. The study seeks to identify correlates to any variability in attitudes toward FTS within this population of PWUD who access other harm reduction services in both urban and rural areas.

## METHODS

The study was conducted in 2023 in collaboration with community-based organizations that provide harm reduction services and syringe exchange services in urban downtown Knoxville and rural Claiborne County, Tennessee. Initial recruitment involved direct interaction with people receiving services at the community agencies. Users interested in participating in the survey were screened for eligibility which included: being age 18 or older, reporting positive current drug use, and the ability to give informed consent. Surveys were administered in private locations that were agreed upon by the interviewer and respondent. The instruments were read aloud to participants and data was then recorded anonymously. Data collection lasted approximately 15-20 minutes with each participant. Questions pertained to fentanyl test strip use and willingness to use FTS strips, current and past drug use, overdose history, implications of drug use, perceptions of drug use in the community and potential solutions as well as demographics. Questions were designed using either the Likert scale (strongly disagree, disagree, neutral, agree, strongly agree, quantified as 1-5; i.e., "I would take additional precautions if a fentanyl test strip showed a positive result") or as multiple choice (i.e., "Which drugs do you currently use?").

A total of 41 participants met eligibility requirements and their responses were anonymized, cleaned and subsequently analyzed. Some of our survey questions resulted in categories with very few responses or sparse data. Because sparse data can produce unreliable statistical estimates, collapsing variables can mitigate this issue by ensuring that each new category has a sufficient number of observations to allow for valid statistical analysis. Survey participants were asked how often they currently use specific types of drugs, and while there was a significant range of substances reported, there were nevertheless three main categories of drugs. Most of the participants that were then collapsed based on those who use the following substances daily and multiple times per day: those who regularly use amphetamines (14 participants), those who regularly use both amphetamines and opioids (4 participants), and those who regularly use opioids without amphetamines (8 participants). The opioid category included people that reported using heroin, fentanyl, and opioids other than heroin. The amphetamine category included those who reported using methamphetamine, amphetamines, and prescription stimulants (Table 1).

We used these three categories of substances as a proxy for drug "preference." We did this to ascertain any differences in attitudes toward FTS as a function of which type of substance a given person purportedly prefers, given the nature of the so-called "fourth wave" of the overdose crisis, which is defined by mixing stimulants and fentanyl.

Most of the population sample self-identified as White (71.1%) and non-Hispanic (82.2%), with a slight majority of the sample self-identifying as female (55.6%), with the

average age of respondents at 42 (min 19, max 70, sd 12.1). We sought to have as much representation as possible on matters of race, ethnicity, sex, gender and age, but the sensitive nature of the subject matter likely impacted our sample population. 62.3% reported being single, never married, divorced, separated, or widowed, 68.9% reported being unemployed, “high school diploma/GED”

and “some college” were the top two most common responses to educational attainment, with 20% of respondents reporting that they did not graduate high school. 44.4% reported that they were currently without housing, and 19.6% reported that they were temporarily staying with a friend or relative or in a shelter.

**Table 1**

<b>How often do you CURRENTLY use the following substances? - Heroin</b>			<b>How often do you CURRENTLY use the following substances? - Methamphetamine</b>		
	N	%		N	%
Less than Once Per Month	3	7.3%	Less than Once Per Month	3	7.3%
Once a Month	1	2.4%	Once a week	1	2.4%
2-3 times a week	2	4.9%	2-3 times a week	5	12.2%
Daily	3	7.3%	Daily	6	14.6%
Multiple times per day	8	19.5%	Multiple times per day	12	29.3%
Missing	24	58.5%	Missing	14	34.1%
<b>How often do you CURRENTLY use the following substances? - Fentanyl</b>			<b>How often do you CURRENTLY use the following substances? - Amphetamines</b>		
	N	%		N	%
Less than Once Per Month	2	4.9%	Less than Once Per Month	2	4.9%
Once a Month	1	2.4%	Once a Month	1	2.4%
Once a week	0	0.0%	Once a week	1	2.4%
2-3 times a week	3	7.3%	2-3 times a week	5	12.2%
Multiple times per day	4	9.8%	Multiple times per day	4	9.8%
Missing	31	75.6%	Missing	28	68.3%
<b>How often do you CURRENTLY use the following substances? - Opioids other than Heroin</b>			<b>How often do you CURRENTLY use the following substances? - Prescription stimulants (ADHD medication)</b>		
	N	%		N	%
Less than Once Per Month	4	9.8%	Less than Once Per Month	1	2.4%
Once a Month	3	7.3%	Once a Month	0	0.0%
2-3 times a week	3	7.3%	2-3 times a month	1	2.4%
Daily	1	2.4%	Daily	0	0.0%
Multiple times per day	1	2.4%	Multiple times per day	1	2.4%
Missing	29	70.7%	Missing	38	92.7%

## RESULTS

### FTS perceptions and use behaviors

The results of the survey reveal important findings related to FTS usage and perceptions. 71% of respondents expressed concern that the drugs they use may contain fentanyl, and almost a third (28.9%) reported that they already were currently using FTS. Participants overwhelmingly reported a willingness to use FTS to test their drugs (88.9%), with 64% stating that they would do so specifically to avoid overdosing, while 21% indicated that they would use FTS to verify the presence of fentanyl in substances (which could indicate either the desire to avoid or seek out fentanyl). Interestingly, some respondents stated that they would use FTS to protect their friends from overdosing in an open ended response. Participants who were willing to use FTS reported that they would need an average of three per day, and 83% said they would be willing to wait five minutes or longer for the test strip to result, which is the amount of time recommended by manufacturers of FTS in order to ensure a low likelihood of a false result.

### FTS and overdose precaution behaviors

Respondents were asked if they normally take precautions to prevent overdose, and the overwhelming majority (87.8%) of respondents reported that they did, including making sure naloxone (Narcan™) is on-hand (68.4%), avoiding using drugs alone (55.3%), and avoiding intentionally mixing multiple drugs and alcohol (57.9%).

Respondents were then asked if they would take additional precautions if they used FTS that tested positive, indicating fentanyl in the tested substance. Participants overwhelmingly agreed that they would take additional precautions, with 80.5% answering “strongly agree” and 12.2% “somewhat agree,”

(mean = 4.53, on scale 1-5; n=41). Only three participants, or 7.3%, disagreed with taking additional precautions to prevent overdose (Table 2).

**Table 2**

Please rate the following statements on fentanyl test strips:

**“If my drugs tested positive for fentanyl, I would take additional precautions.”**

	N	%
Strongly disagree	2	4.9%
Somewhat disagree	1	2.4%
Somewhat agree	5	12.2%
Strongly agree	33	80.5%

Later in the survey, we asked specifically what precautions people normally take to avoid overdose, followed by what additional precautions they would take, if any, should their drug test positive for fentanyl. In this question, 87.8% said they would take an additional precaution, with the most common response (noted by 47.2% of respondents) being to make sure that naloxone was immediately available. Taking a lower dose than usual was another popular precaution, with 41.7% of respondents indicating they would do so. About a third of the participants (30.6%) would contact a friend to inform them that they were using the drug, and the same percentage (30.6%) would only use the drug if someone else was present. Importantly, in an open ended response, 24% of respondents stated they would not use the drug that tested positive for fentanyl, with some respondents saying they would try to quit using drugs altogether. 19.4% would change their method of drug delivery, for example, smoking instead of injecting, as a precaution. A small minority of respondents, only 12.2%, indicated they

would not take any additional precautions if their drug tested positive for fentanyl beyond what they normally do to avoid overdose.

There was a slight but insignificant difference between the proportion of people saying they would not take additional precautions depending on the framing of the question (7.3% versus 12.2%), but the vast majority of respondents in both questions reported they would take additional precautions in light of their drug testing positive for fentanyl.

**FTS and willingness to use a drug that tests positive for fentanyl**

When asked to agree or disagree to the statement “if a [FTS] showed there was fentanyl in my drugs, I would still use the drug,” a slight majority of respondents indicated that they disagreed (mean = 2.6 on scale 1-5; n = 41), with 43.9% stating “strongly disagree” and 7.3% answering “disagree.” In other words, 51.2% of respondents said they would not use the drug in question. Considering the likely influence of the social desirability bias, it is crucial to point out that when asked directly, 51.2% of respondents said they would not use the positive substance in question, but in a different and open ended question about what additional precautions people would take in light of a positive FTS, 24% volunteered that they would not use or discard the positive substance without a prompt.

**Drug preference (regular use of amphetamines, opioids, or both) and willingness to take additional overdose precautions**

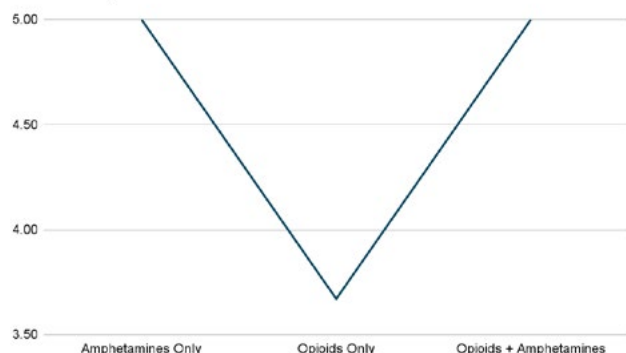
Willingness to take additional precautions in light of a positive FTS differentiated depending on drug use patterns. When respondents were grouped by daily or multiple times per day use of amphetamines, opioids, or amphetamine plus opioids, we

identified notable patterns with respect to FTS perceptions.

Importantly, the overall mean rating across all three groups was 4.56 with a standard deviation of 1.086, showing that participants were likely to take additional precautions regardless of what substance they reported using. However, participants who use amphetamines, either with or without opioids, rated their likelihood to take additional precautions to avoid overdose as a consistent 5.00, indicating the highest agreement with taking additional precautions. In other words, 100% of participants that reported daily use of amphetamines (including methamphetamine), whether with or without opioids, reported a strong willingness to take additional precautions in light of a positive FTS. Those who reported using opioids without amphetamines had a lower mean rating of 3.67 with a standard deviation of 1.581, indicating that they were less likely to take additional precautions, though the majority were still willing to take additional precautions in light of a positive FTS (Fig. 2).

A one-way ANOVA between the groups ( $F(2,24)=6.400, p=0.006$ ) indicated that there is a statistically significant difference in the

**Fig. 2. If my drug tested positive for fentanyl, I would take additional precautions to avoid overdose.**

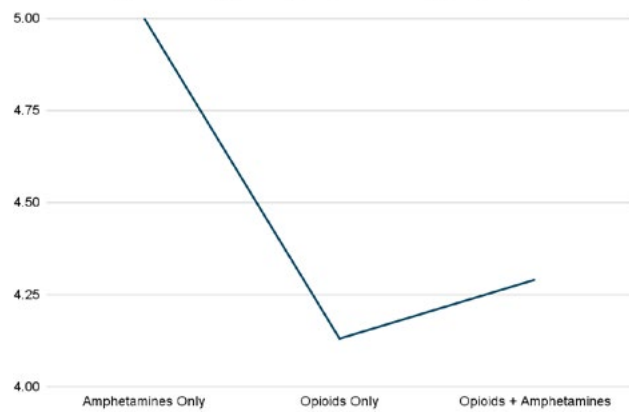


self-reported likelihood of taking additional precautions if drugs tested positive for fentanyl between those who reported daily use of amphetamines, those who use both amphetamines and opioids, and those who use opioids without amphetamines. A post hoc Fisher’s Least Significant Difference (LSD) test showed significance in mean difference between the amphetamine group and the opioid group (Table 3). This suggests that people who use amphetamines (including methamphetamine) are especially likely to take additional precautions to prevent overdose when their drugs test positive for fentanyl.

We then broadened the classification of the amphetamine-only, opioid-only, and amphetamine-and-opioid-only groups to include weekly users as well as daily, to see if there were still significant differences noted (Fig. 3). While a repeat ANOVA resulted in a non-significant  $F(2,28)=2.689$ ,  $p=0.085$ , a post hoc Fisher’s LSD test yielded a significant difference ( $p = 0.046$ ) between the mean responses of the amphetamine-only and opioid-only groups (Table 4).

When asked if they agreed or disagreed with the statement “if a [FTS] showed there was fentanyl in my drugs, I would still use the drug,” we found that people who used just amphetamines or just opioids were more likely to disagree, indicating that they would not use the drug in question (Fig. 1). People who regularly used both opioids and amphetamines were more likely to agree with the statement.

**Fig. 3. If my drug tested positive for fentanyl, I would take additional precautions to avoid overdose. (1=strongly disagree, 5=strongly agree)**



**Table 3**

**Post hoc Fisher’s LSD**

*Groups are defined by reported daily and multiple times per day use.*

		Mean Difference	Std. Error	Sig.
Amphetamine	Opioid	.875*	0.419	<b>0.044</b>
	Opioid and Amphetamine	0.714	0.439	0.112
Opioid	Amphetamine	-.875*	0.419	<b>0.044</b>
	Opioid and Amphetamine	-0.161	0.501	0.750
Opioid and Amphetamine	Amphetamine	-0.714	0.439	0.112
	Opioid	0.161	0.501	0.750

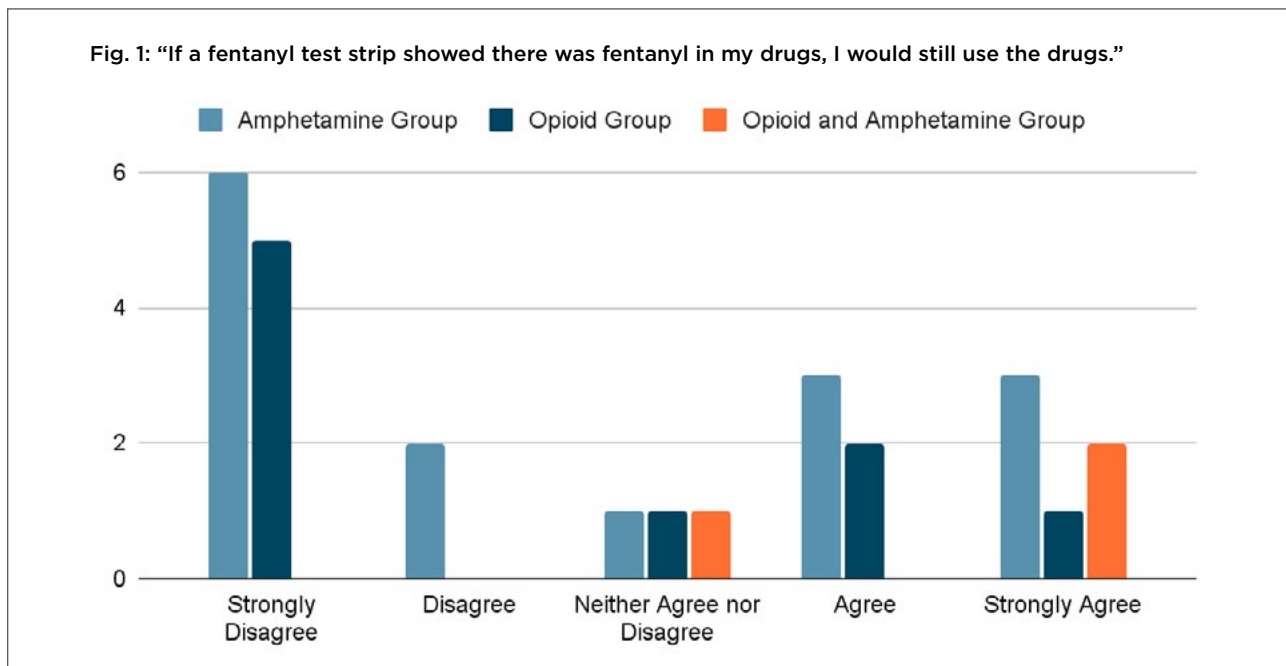
**Table 4**

**Post hoc Fisher’s LSD**

Groups are defined by reported daily, multiple times per day, once a week and 2-3 times per week use.

		Mean Difference	Std. Error	Sig.
Amphetamine	Opioid	.875*	0.420	<b>0.046</b>
	Opioid and Amphetamine	0.714	0.439	0.115
Opioid	Amphetamine	-.875*	0.420	<b>0.046</b>
	Opioid and Amphetamine	-0.161	0.502	0.751
Opioid and Amphetamine	Amphetamine	-0.714	0.439	0.115
	Opioid	0.161	0.502	0.751

\*. The mean difference is significant at the 0.05 level.



The data suggests that people who use drugs in both urban and rural contexts are likely to use fentanyl test strips to test their substances for fentanyl, and the majority would take additional precautions to avoid overdose in light of a positive test. Those who regularly use amphetamines, with or without opioids, are even more likely to take additional precautions compared to those using opioids alone.

**DISCUSSION**

Overall, this study shows that FTS would be used by people who use drugs in urban and rural contexts, regardless of types of drugs they consume. This study also shows significant reported positive attitude change toward drug use behaviors that reduce the risk of overdose in light of a positive test for fentanyl. However, our findings also suggest that this strategy is significantly under-utilized.



Almost 90% of respondents stated that they would use FTS if supplied, and on average, respondents said they would use three test strips per day if available. However, less than 30% of respondents reported currently using FTS, indicating a lack of access for several reasons (first and foremost being that many of the study population were unhoused and unemployed).

Considering that about two-thirds of fatal overdoses in Tennessee are male (CDC 2022, 2024), and a little over half of our respondents self-identified as female, it may be that those identifying as females are more likely to use FTS and respond with behavior change to avoid overdose death, but further research with a larger sample size would be needed to explore this potential relationship.

Respondents overwhelmingly agreed that they would take additional precautions to prevent overdose in light of a positive FTS, with the most common additional precautions being acquiring naloxone, taking a lower dose of their drug, and either not using alone or informing a friend they were about to use a drug that tested positive for fentanyl. About a fourth of respondents said they would not use or discard the drug that tested positive for fentanyl, with some even suggesting they would attempt to enter long term recovery. Only about 12% of respondents said they would not take additional precautions if their drugs tested positive for fentanyl.

64% of respondents specifically said they would use FTS to prevent overdosing, while an additional 21% reported they would use FTS to check for the presence of fentanyl. This latter reason could be interpreted as comparable to the first, or it could be in line with a common criticism of FTS, namely

that FTS could be used to seek out fentanyl for euphoric purposes as opposed to harm reduction purposes. However, considering also that only about 12% of respondents reported they would not take additional overdose prevention precautions, it is clear that the vast majority of respondents would use FTS to prevent an overdose death. In other words, we did not find evidence that people who use drugs were interested in using FTS to verify that they had purchased high-potency substances to ‘get a better high.’ On the contrary, we found that people who use drugs are overwhelmingly concerned about accidentally encountering fentanyl and suffering a fatal overdose, and are interested in using FTS to help them prevent their own or a friend’s or loved one’s death.

This study also suggests that FTS may be even more impactful among populations that primarily use amphetamines, whether with or without opioids. Considering that the study population sampled from rural areas overwhelmingly skewed toward using amphetamines, particularly methamphetamine, our analysis suggests that FTS may be of particular interest to overdose prevention efforts in rural areas with higher rates of methamphetamine use. The majority of those who use opioids without amphetamines still indicated an overwhelming interest in using FTS and that they would take additional precautions to prevent overdose in light of a positive test. Furthermore, as we are currently in what has been widely described as the “fourth wave” of the overdose crisis (Ciccarone, 2021), characterized by stimulant and opioid mixing among other polysubstance use, these findings may have a certain degree of generalizability to areas with a high rate of stimulant use and concurrent polysubstance overdose.

## LIMITATIONS

This study has several limitations, primarily a small sample size, which limited statistical inferences and generalizability. Of course, considering the nature of the substance using population, it is very difficult to get large sample sizes. Similarly, data was collected by voluntary survey and may be influenced by the social desirability bias. Finally, due to ethical, legal, and privacy concerns, no actual drug use was observed, and only data on reported potential attitude changes could be collected, not actual drug use behaviors.

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## ETHICAL APPROVAL

This research received ethical approval from the Institutional Review Board (UTK IRB-22-07128-XP, approved on April 27th, 2023 by Lora Beebe, Ph.D., PMHNP-BC, FAAN, Chair of the UT IRB).

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