Update on Soil Fumigation: MBr Alternatives and Reregistration Decisions

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Abstract: This article gives a brief history of the importance of methyl bromide in the production of forest seedlings in the southern United States and the timeline for the Montreal Protocol and Clean Air Act to phase out ozone-depleting compounds. In addition, the process, steps, and potential for continued MBr use under the Critical Use Exemption and Quarantine Pre-shipment articles within the treaty are discussed. A summary of the re-registration decisions proposed by the US Environmental Protection Agency for the re-registration of all soil fumigants under the Food Quality Protection Act is outlined as well as current status of MBr alternatives available for the production of forest seedlings in the southern United States.

Keywords: Montreal Protocol, Critical Use Exemption, Quarantine Pre-shipment, Reregistration Decisions

Introduction

In the early 1980s, a consensus emerged in scientific circles that the concentration of stratospheric ozone was declining and that chlorinated fluorocarbons (CFCs) were the cause. To address the ozone hole, the Montreal Protocol on substances that deplete the ozone layer was signed in 1987 to bring about the eventual phase-out of all CFCs. In 1991, methyl bromide (MBr) was added to the list of ozone-depleting compounds, and the amount of MBr produced and imported in the US was reduced incrementally until it was phased out by 1 January 2005 under the *Montreal Protocol* and the Clean Air Act (CAA). Allowable exemptions to the phase-out of MBr included the Critical Use Exemption (CUE) and the Quarantine and Pre-shipment (QPS) exemption, both designed for agricultural users with no technically or economically feasible alternatives.

Methyl Bromide

MBr is an odorless, colorless gas that has been used as a soil fumigant in most southern forest seedling nurseries to control a wide range of soil-borne pests and enhance seedling production (Carey and McNabb 1996). MBr has proven to be a reliable pesticide for the past 50 years, and has been the industry standard in every pest management program in forest seedling nurseries. The use of MBr to control nursery pests has reduced the demand for more specific herbicides, fungicides, and insecticides. Prior to the MBr phase-out in 2005, 96% of southern forest seedling nurseries used soil fumigation, and 90% of that fumigation was done with MBr (Jang and others 1993). Generally, MBr was applied once every 3 to 4 years, based on 2 to 3 years of pine production followed by 1 to 2 years of cover crop. The total amount of MBr used is estimated at 73,000 kg (161,000 lb) and was approximately 0.33% of the estimated 22 million kg (49 million lb) used for soil fumigation in the US in 1990 (Anonymous 1993). The extensive use of MBr in forest seedling nurseries across the southern US was the best indication of its consistent effectiveness across a wide range of soil and environmental conditions.

Critical Use Exemptions

CUEs are permitted under Section 604(d) of the Clean Air Act and the Montreal Protocol. Under Decision IX/6 of the Protocol, the use of MBr should qualify as critical use only if the nominating Party (the US, for example) determines that: a) the specific use is critical because the lack of availability of MBr for that use would result in a significant market disruption;

and b) there are no technically and economically feasible alternatives or substitutes available to the user that are acceptable from the standpoint of environmental and public health and are suitable to the crops and circumstances of the nomination.

Beginning in 2004, the US Environmental Protection Agency (EPA) requested applications for CUEs from growers that continue to need and use MBr in their production systems. Generally, CUE applications for MBr use is by consortium or groups of growers/users. A CUE application includes a number of questions on current MBr use, production data, pest issues, research and efficacy on alternatives, methods to reduce MBr emissions, and so on that can be used by EPA to determine the "critical use." An onerous document, the 2009 Southern Forest Nursery Management Cooperative's CUE application was 77 pages in length. After reviewing the CUE applications, EPA develops a Methyl Bromide Usage Numerical Index (BUNI /BUNNIE) for each consortium/group requesting MBr that takes into account each request, subtracts double reporting and quarantine pre-shipment uses, and nominates an amount of MBr for that consortium to the State Department. From the various BUNI/BUNNIEs, the US Government requests authorization for those critical uses from the Parties (Methyl Bromide Technical Options Committee [MeBTOC]) to the Montreal Protocol. Once the Parties of the Protocol authorize the request for a critical use and an amount of MBr for those critical uses, EPA publishes a rule in the Federal Register allowing for the additional production of MBr for that critical use in that year. Each application for a Critical Use round takes up to 3 years and is conducted annually. Thus, for those forest seedling nurseries that use CUE MBr in 2010, the application process began in July 2007 and the current 2010 CUE application is for the 2013 growing season.

As growers adopted different pest management systems, the number of Critical Users has decreased over time. In 2010, there were 11 pre-plant and 3 post-harvest users/growers authorized to use MBr under the CUE process as outlined under the Montreal Protocol. Within the pre-plant users are the Forest Nursery Seedlings groups that include six different forest seedling consortiums throughout North America approved to use MBr in their production systems. Some of the other critical users include commodities, orchard replant, sweet potato slips, and fruit, nut, and flower nurseries. The primary objective of the Montreal Protocol and the Clean Air Act was to reduce, and eventually eliminate, the use of all ozone-depleting compounds, including MBr. Thus, since the first CUE in 2005, the amount of MBr requested by US growers, the amount authorized by the State Department, and amount approved by the Parties has steadily declined from 9.4 million kg (20.8 million lb) in 2005 to 2 million kg (4.5 million lb) in 2011 (Figure 1).

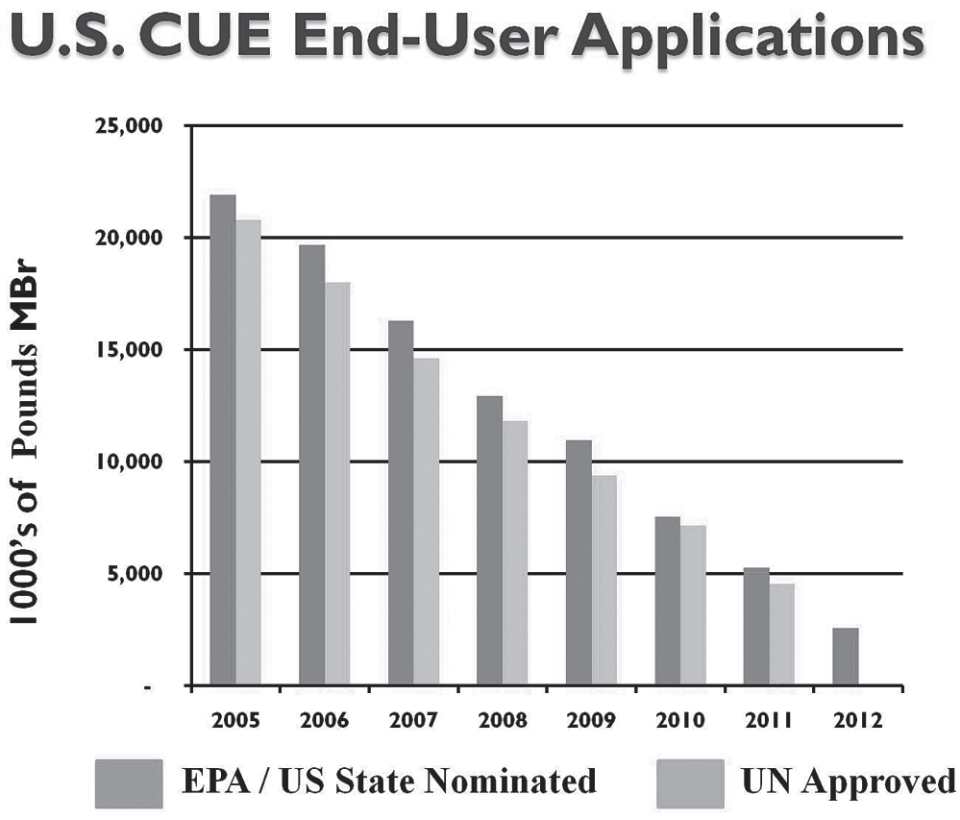

Figure 1. United States methyl bromide nominations and United Nations-approved methyl bromide use under the Critical Use Exemption process for 2005 to 2012.

Quarantine and Pre-shipment Exemption

As part of the Montreal Protocol, the QPS rule implements an allowable exemption for production and consumption of MBr for quarantine and pre-shipment purposes. Article 2H, Paragraph 6 of the Montreal Protocol states that "the calculated levels of consumption and production under this Article shall not include the amounts used by the Party for quarantine and pre-shipment applications." The EPA agreed to the Montreal Protocol's definitions of quarantine and pre-shipment. The QPS exemption is based on self-certification of the individual Parties as described in UNEP (2003).

Quarantine applications are treatments to prevent the introduction, establishment, and/or spread of quarantine pests (including diseases), or to ensure their official control, where: a) official control is that performed by, or authorized by, a national plant, animal, or environmental protection or health authority; or b) quarantine pests are pests of potential importance to the areas endangered thereby and not yet present there, or present but not widely distributed and being officially controlled.

An example of a quarantine application of MBr is the fumigation of a commodity, such as potatoes in Idaho, that are subject to infestation by a specific and officially recognized quarantine pest, such as the pale cyst nematode (*Globodera pallida*), when the fumigation is conducted before transport of the commodity to meet official quarantine requirements. The purpose of quarantine fumigation is to prevent the introduction of specific quarantine pest(s) into a defined geographical area, such as an importing country. "Pre-shipment applications" are those non-quarantine applications that are within 21 days of export that need to meet the official requirements of the importing country or the existing official requirements of the exporting country. Official requirements are those that are performed by, or authorized by, a national plant, animal, environmental, health, or stored product authority.

As part of the CUE application and approval process, when EPA develops the BUNI/BUNNIE for each critical user, they routinely deduct a percentage of the MBr requested for each user for QPS. For example, in 2006 the Southern Forest Nursery Management Cooperative requested 111,600 kg (246,000 lb) of MBr for use in 2009 for all forest seedling producers in the southern US. From that amount, EPA deducted 66% (37,650 kg [83,000 lb]) for QPS uses, and submitted 74,000 kg (163,000 lb) to MeBTOC for CUE approval. Since the phase-out of MBr use in 2005, there has been an increase in the amount of MBr assigned as "QPS MBr" (Figure 2). Correspondingly, there has been a push by the European Union (EU) nations to significantly reduce QPS use worldwide. There have been some claims made by other nations that the US is playing games with EU and that pre-plant uses lack efficacy data to adequately get control based on EU standards. Thus, at the International Plant Protection Convention, there were plans to rework definitions as outlined in the Montreal Protocol. At the heart of the matter is that the EU claims that state boundaries, as listed and used by the US, do not qualify for usage as QPS and that the definitions as outlined in the Montreal Protocol were for International Boundaries. Specifically, any rule put into place in the US after 1993 does not count based on international rules.

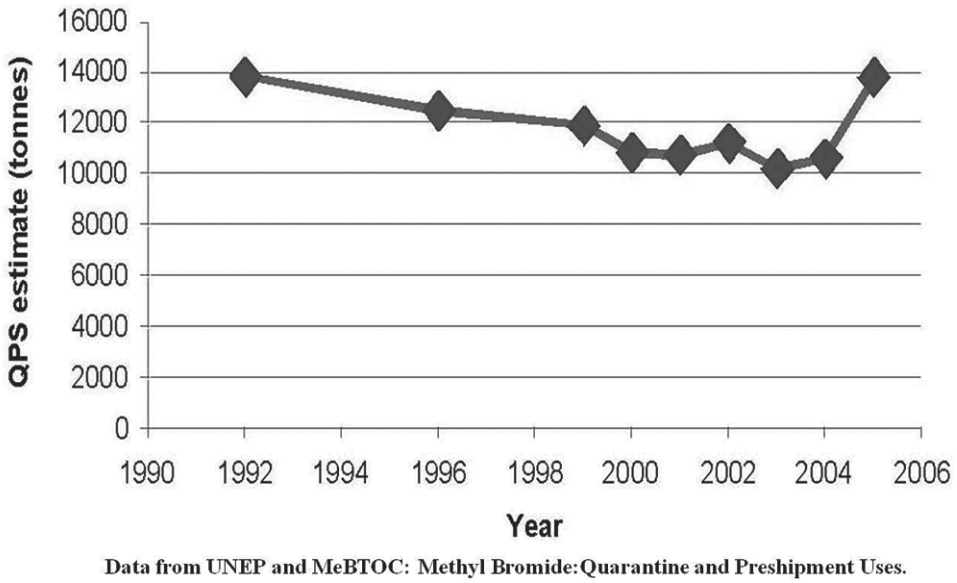

Figure 2. Worldwide use of methyl bromide classified as Quarantine and Pre-shipment use for 1990 to 2005. (Methyl Bromide: Quarantine and Pre-shipment Uses [UNEP 2003; page 15]; 1 tonne = 1.1 ton).

In early 2010, as Director of the Southern Forest Nursery Management Cooperative (SFNMC), I was contacted by representatives within the EPA, USDA Animal and Plant Health Inspection Service (APHIS), and the US State Department to clarify the role the Nursery Cooperative plays in the CUE application process as it pertains to QPS. The question posed to me was, "If the production of forest seedlings falls under the QPS umbrella for MBr use, why does the Nursery Cooperative even file the request for a CUE MBr use?" To that end, copies of the 12 southern State Plant Pest Requirements for Pest-Free Certification on forest-tree seedling production were forwarded to those agencies for their use in negotiating CUE and QPS MBr use with the EU and MeBTOC.

The CUE and the QPS amendments were not intended to be a permanent solution for continued MBr use. While there is no "cut-off" date for either of these programs (there are still a few chlorofluorocarbons (CFCs) in use 15 years after their phase-out), the overall objective of the Montreal Protocol and the Clear Air Act was to eventually phase out and stop all uses of MBr. In July 2010, EPA announced that the agency was considering ending the CUE program by 2014, with 2013 as the last year MBr would be available under the CUE process. That has provided US growers with an additional 6 years beyond the 2005 phase-out of MBr to implement ozone-safe alternatives. According to EPA, production and consumption of methyl bromide has "declined significantly over the last 20 years," particularly since the substance was phased out in 2005. The CUE since that time was meant to give affected industries time to develop viable alternatives to ozone-depleting substances. Developing countries have until 2015 to phase out MBr. The US was one of only five countries to request the critical use exemptions for methyl bromide in 2010. Israel has announced it will end its critical use program after 2011, while Japan has said it will no longer request the exemptions after 2013.

MBr Alternatives

It is an understatement to mention that significant time, effort, and dollars have been spent within the agricultural community in an attempt to identify an economical and technical alternative to MBr. Since 1991, when the SFNMC began to look, in earnest, for a replacement, over US$ 2 million of its annual dues have been spent on research to find an alternative to MBr. In early 1991, the choices for MBr replacement were chloropicrin, 1,3-dichloropropene, dazomet, and metam/potassium sodium, either alone or in combinations (Carey and McNabb 1996). Since that time, data collected from numerous trials on seedling production, pest control, and application issues have narrowed that list to just chloropicrin and 1,3-dichloropropene (Telone®), alone or in combinations. Fortunately, there has been new chemistry developed and these new soil fumigants include Pic + (chloropicrin + a solvent), dimethyldisulfide (DMDS = Palidin®), and methyl iodide (MI; iodomethane = Midas®). A few compounds that are currently under examination in other crop systems that use MBr, but not yet tested by the SFNMC, include sulfuryl fluoride, phosphine, halosulfuron, furfural, and napropamide.

None of the soil fumigants tested, however, has performed equally in all nurseries in all situations. While producing decent seedling characteristics, Palidin® (DMDS + chloropicrin) has significant odor issues that last long into the growing season. Unless the odor is eliminated, adoption of this particular alternative is doubtful. Since its labeling in 2008, restrictions on the availability and application of Midas® have limited research to one study in one nursery in 2009. Studies with other alternatives have shown that soil type, pest pressures, cropping history, and nursery location affect the efficacy of soil fumigants (Starkey and Enebak 2008; Quicke and others 2009a,b; Quicke and others 2010a,b). More studies with this compound in other nurseries and soils are needed. Data collected in 2005, prior to the label approval of Midas®, showed that iodomethane produced decent seedling characteristics, a significant reduction on *Trichoderma* spp., but poor weed control (Starkey and others 2006). The soil fumigant Pic + (chloropicrin + a solvent) has been one of the better MBr alternatives across a wide range of soils and nurseries where it has been tried (Starkey and Enebak 2008; Quicke and others 2009a,b; Quicke and others 2010a,b). Weed control issues have occurred in some nurseries with this compound. This is not surprising, as chloropicrin is not known for efficacy in weed control (Carey and McNabb 1996; South 2006). The eventual loss of MBr is going to result in individual nurseries needing to fine-tune their seedling production and pest control treatments more carefully, because MBr allowed for a larger margin of error.

Reregistration Eligibility Decisions

Superimposed on the CUE process, the QPS rules, and the agencies that fall under the Montreal Protocol and the Clear Air Act is the enactment of the Food Quality and Protection Act (FQPA) of 1996. With the passage of the FQPA, congress presented EPA and all producers and users of pesticides with the challenge of implementing the most comprehensive and historic overhaul of the nation's pesticide and food safety laws in decades. Some of the major requirements include stricter safety standards, especially for infants and children, and a complete reassessment of all existing pesticide tolerances for all uses and users, applicators, handlers, and bystanders.

In 2006, EPA began the process of reviewing the safety of all compounds that are used as soil fumigants in an attempt to mitigate bystander exposure, taking into consideration application methods, soils, compounds, rates, crops, and so on, and develop rules on usage and application methods as part of the reregistration of each soil fumigant. The compounds examined in this reregistration process included chloropicrin, dazomet, metam/potassium sodium, methyl bromide, 1,3-dichloropropene (Telone®), methyl isothiocyanate (MITC), and iodomethane as a group to ensure that similar risk assessment tools and methods were used for all, and risk management approaches were consistent.

It would be an understatement to suggest that the first proposed rules of the EPA in February 2007 were a blow to nearly 15 years of MBr alternative research in the forest seedling arena. At a meeting in Crystal City, VA, I mentioned to the EPA personnel who had agreed to meet with a few stakeholders (forest seedlings, potatoes, orchard replant,

strawberries) on the newly proposed re-registration decisions (REDs) that "these rules were a punch in the stomach to all those who had been trying to identify and locate an alternative to MBr." For example, using the newly proposed EPA rules for soil fumigants, a 4-ha (10-ac) block (nursery average) fumigated with 160 kg (350 lb) chloropicrin under a High Density Plastic, the best alternative to MBr (see South and others 1997; South 2006) would require a buffer zone of 1400 m or 1.3 km (4200 ft or 0.8 mi). Along with the other proposed rules, the SFNMC estimated that 50% of the forest seedling nurseries would have ceased operations due to a loss of production areas within 3 years with the remaining nurseries significantly increasing seedling costs (SFNMC 2007). It turns out that the best "alternative" to the 2007 proposed soil REDs was the soil fumigant MBr, because this compound required a much smaller buffer zone than straight chloropicrin. For someone who has been working on soil fumigants since 1985 (Enebak and others 1990a,b,c), the irony of identifying an alternative to MBr under the Montreal Protocol and the 2007 Soil REDs was simply a bitter pill to swallow.

Fortunately, after a number of EPA "comment periods" that included new soil flux data, information on seedling production systems, identification of high barrier tarps, evaluation of new technologies, and shareholder input, a revised and amended Soil RED was released in May 2009. These new rules will affect all aspects of soil fumigation for years to come and will require that producers, applicators, and users play a role in the safe and proper application of soil fumigants for the production of forest seedlings. These steps include buffer zones, posting requirements, agricultural worker protection, applicator and handler training programs, tarp perforation and removal, good agricultural practices, application methods/practices and rate restrictions, new restricted use designation for Dazomet, site-specific fumigation plans, emergency preparation and response requirements, compliance assistance and assurance measures, and community outreach and education programs. A complete listing of all the requirements outlined in the Final Soil RED can be accessed at EPA (URL: http://www.epa.gov/opp00001/reregistration/soil_fumigants/#background). All of these measures are going to take a lot of time, effort, and money on someone's part to comply. Thus, the cost to use soil fumigants in the production of forest seedlings is going to increase more than it already has.

Prior to the implementation of the Montreal Protocol and the phase-out of MBr, the average cost to fumigate nursery soil was just over $US 3700/ha (US$ 1500/ac) (Figure 3). After 2005, there were two sources of MBr (CUE and QPS);the cost was less for QPS than CUE MBr. These two sources of MBr have increased over time to US$ 4450 and 7160/ ha (US$ 1800 and 2900/ ac) in 2010 for CUE and QPS MBr, respectively. No one (producers or applicators) has any idea of what these new rules will do to the price of any of the soil fumigants (chloropicrin, MBr, Telone®, and so on) available for 2011 and beyond.

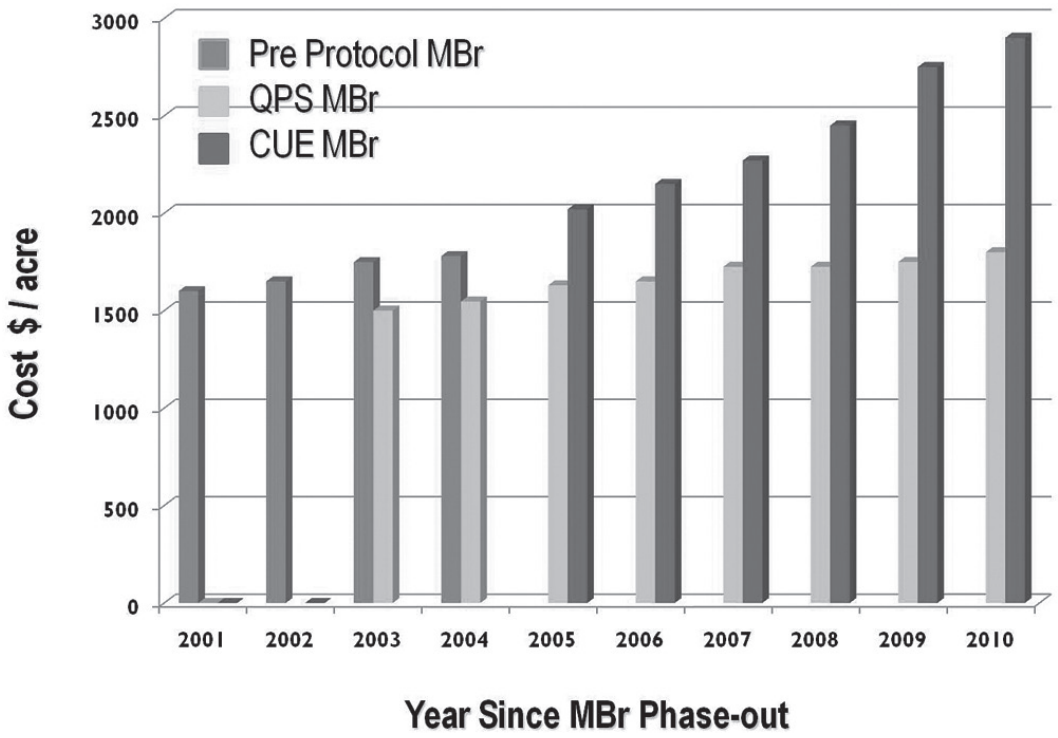

Figure 3. Source of methyl bromide and relative cost per acre to apply in forest seedling nursery settings: 2001 to 2010.

While these new rules will change the way nurseries use soil fumigants, the lifting of the buffer zone overlap restrictions to 24 hours, the incorporation of the new soil flux data into the buffer tables, new plastic tarp technologies that allow the gluing of high barrier plastics (virtually/totally impermeable films [VIF/TIF]), and other soil credits should allow nurseries to continue their use of soil fumigants in the production of forest seedlings with minimal disruptions and loss of production acreage. Without these changes, many forest seedling nurseries would have ceased to exist, unable to comply with the bystander safety restrictions. Slated for enforcement in 2010, as of July 2010 many of these requirements have not yet been agreed upon by the registrants and EPA. Full enforcement of all new soil rules and corresponding pesticide labels is scheduled for 2011. That should give producers, applicators, and users a couple of years to work out the kinks as EPA plans to consider the soil fumigants together (all over again) during the Registration Review that begins in 2013.

Summary

The continued availability and use of MBr for the production of forest-tree seedlings is limited to those who have access to a Critical Use Exemption or fall under the Quarantine Pre-shipment rules. Both of these MBr sources are limited and under scrutiny by a number of US governmental and international organizations. A number of soil fumigants have been examined as alternatives to MBr; none has proven to be a drop-in replacement as each has its own unique properties and challenges that will need to be tweaked by individual nursery managers under their own production systems. The new Soil Fumigation REDs will require a concerted effort by producers, applicators, and users to ensure the safety of bystanders and document each application of soil fumigant. While the costs to do so will probably increase, at least the rules allow the continued use of soil fumigants in the unique production systems that are forest seedling nurseries.

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