United States Department of Agriculture

Natural Resources

Conservation Service

CONSERVATION PRACTICE

STANDARD FOREST

STAND IMPROVEMENT

CODE 666

(ac)

DEFINITION

The manipulation of species composition, stand structure, or stand density by cutting or killing selected trees or understory vegetation to achieve desired forest conditions or obtain ecosystem services.

PURPOSE

This practice is used to accomplish one or more of the following purposes–

- Improve and sustain forest health and productivity
- Reduce damage from pests and moisture stress
- Initiate forest stand regeneration
- Reduce fire risk and hazard and facilitate prescribed burning
- Restore or maintain natural plant communities
- Improve wildlife and pollinator habitat
- Alter quantity, quality, and timing of water yield
- Increase or maintain carbon storage

CONDITIONS WHERE PRACTICE APPLIES

All land where the quantity and quality of trees can be enhanced.

CRITERIA

General Criteria Applicable to All Purposes

Describe the extent or size and orientation of treatment area(s).

Identify and retain preferred tree and understory species to achieve all planned purposes and

landowner objectives.

Use available guidelines for species and species groups to determine spacing, density, size-class distribution, number of trees, and amount of understory species to be retained. Schedule treatments to avoid overstocked conditions using approved silvicultural/ stocking guides.

Describe the current and desired future condition of each stand that will be treated. Include the species, cover type, and size-class distribution. Stocking will be described in terms of crop trees per acre, basal area per acre, trees per acre, between-tree spacing, or by any other appropriate and professionally accepted density or stocking protocol.

Refer to WIN-PST criteria in NRCS Conservation Practice Standard (CPS) Integrated Pest Management (Code 595), and comply with applicable State and local laws if an herbicide will be used.

Time tree felling to avoid buildup of insect or disease populations.

Implement forest stand improvement activities in ways that avoid or minimize soil erosion, compaction, rutting, and damage to remaining vegetation, and that maintain hydrologic conditions. Protect site resources by selecting the method, felling direction and timing of tree felling, and heavy equipment operation. For temporary access use NRCS CPS Forest Trails and Landings (Code 655) to protect soil and site resources from vehicle impacts.

Use NRCS CPS Access Road (Code 560) for more heavily used roads associated with forest stand improvement activities.

Where slash and debris will be generated, use NRCS CPS Woody Residue Treatment (Code 384) to appropriately treat slash and debris, as necessary, to assure that it will not present an unacceptable fire, safety, environmental, or pest hazard. Remaining woody material will be placed so that it does not interfere with the intended purpose or other management activities. Do not burn vegetative residues except where fire hazard or threats from diseases and insects are of concern or when other management objectives are best achieved through burning. When slash and other debris will be burned onsite use NRCS CPS Prescribed Burning (Code 338).

Comply with all federal state and local laws and regulations during the installation, operation, and maintenance of this practice. Comply with State best management practices for water quality.

Refer to the latest version of the *Kentucky Forest Practice Guidelines for Water Quality*

Management at: For-67: Kentucky Forest Practice Guidelines for Water Quality

Management (uky.edu)

Destructive livestock grazing reduces the productivity health and vigor of woodlands in Kentucky. Control destructive livestock grazing. Refer to CPS Access Control (472) and/or Fence (382).

Pesticides may be used in the installation of this practice. Kentucky NRCS does not make pesticide recommendations. If pesticides are to be used in the installation of this practice, recommendations for their use may be obtained from the UK Cooperative Extension Service,

the Kentucky Division of Forestry, Kentucky Department of Fish and Wildlife Resources (KDFWR), or approved TSP. Follow all label instructions when applying pesticides.

Forest stand improvement practices are implemented to fully use the potential of a site; to maintain plant cover for soil protection; to improve stand composition by increasing the size, amount, and growing space for desirable tree species with good health, form and vigor, to enhance regeneration and recruitment of desired species; to improve the natural beauty, wildlife, or recreation values of an area.

Forest stand improvement is practiced in forested stands that are overstocked or where desirable trees are overtopped or crowded out by less desirable trees, shrubs, or vines; where removing part of a stand will improve stand quality, or the recreation, wildlife, aesthetic, or hydrologic values of an area.

Refer to the Web Soil Survey soil interpretations for each soil series to find the site index and soils limitations for forested stands. Utilize site index for species representative of the site. In absence of known species utilize northern red oak site index for planning purposes.

Invasive tree species may be identified and selected for removal. Elimination from the stand may require herbicide treatment or other measures. Understory shrub species should be treated under CPS Brush Management (314).

Forest stand improvement objectives (timber production unless otherwise stated) can be accomplished with any of the following practices or a combination thereof:

1. Pre-commercial Thinning (Timber Production Emphasis) – The pre-commercial thinning practice is a treatment applied throughout an entire immature forested stand to regulate stand density and

   stocking. Its purpose is to accomplish stand specific landowner objectives (primarily timber production) that can be realized by concentrating growth on trees with better form and higher potential value as a timber product. This silvicultural treatment will improve the vigor of the stand and subsequently, the health of the residual stand. The landowner can remove trees with poor health, form, and vigor, and limit the number of undesirable species and improve the spacing of the remaining trees.

   The stand should have a northern red oak site index of at least 60 for the preferred timber species and have dominant and co-dominant trees that are at least 25 feet in height. At least 20 square feet of basal area should be removed. Crown thinning should generally be used to remove enough from other crown classes to achieve the desired basal area and stocking level. Pre-commercial thinning should typically be conducted in poletimber and/or small sawtimber stands (4”–12” diameter at breast height (DBH)).

2. Area-Wide Thinning (Wildlife Management Emphasis) - no minimum stand site index is required; however serious consideration to heavy thinning should be given to soils with site indices less than 40 for northern red oak to avoid erosion potential. The basal area removed will be determined based on the species habitat needs. As a guideline thinning usually requires the minimum removal of 40 square feet of basal area. Crown thinning should generally be used to remove enough from other crown classes to achieve the desired basal area and stocking level. Area wide thinning for wildlife should typically be conducted in poletimber and/or small sawtimber stands (4”–12” diameter at breast height (DBH).

3. Cull Tree Removal - Cull tree removal is the practice of felling or deadening non-merchantable trees, including wolf trees, deformed trees, and weed trees for the purpose of providing room for the main crop trees to continue and increase their development of the main stand. Cull tree removal should be considered when timber production is the primary objective.

   A cull tree is any tree 4"DBH and larger that contains so little merchantable material because of rot, crook, sweep, and other defects; or of inferior species that it cannot be harvested at a profit and is interfering with the development of the main stand. The purpose of cull tree removal is to provide room for the main crop trees to continue their development.

   Cull tree removal is applicable in stands with a northern red oak site index of 60 or better for northern red oak having a high percentage of non-merchantable trees because of defects or undesirable species. Stands must have a minimum of 20 crop trees per acre or potential crop trees that will benefit from cull removal. For even-aged stands, cull tree removal should not reduce the stand stocking below the "B" level. Refer to **Figure 1 –** *Stocking Levels for Upland Hardwood***s**. For uneven aged stands 50 square feet of basal area of trees 6" DBH and over should be the minimum stocking.

   Culls may be manually felled or deadened with herbicide or through girdling; however, deadening is recommended if felling of trees will cause appreciable damage to residual trees. Timing of the application of cull tree deadening will influence how quickly the trees succumb to the effects of herbicide and/or girdling.

   The killing of the cull trees may be accomplished by mechanical girdling with a chainsaw or through the use of herbicide on trees that are prone to sprouting such as red maple. Herbicide recommendations for deadening of trees that are more vulnerable to sprouting after cutting may be obtained from the UK Cooperative Extension Service, the Kentucky Division of Forestry, Kentucky Department of Fish and Wildlife Resources (KDFWR).

   Den trees, nut trees, cull, and wolf trees valuable to wildlife may be left.

4. Grapevine Removal – Grapevines are deadened to stop present damage and reduce or prevent future damage to quality hardwood stands.

   This practice should not be applied in stands where co-dominant trees are less than 15 feet tall and a well-developed closed canopy is not present.

   It is recommended that a timber harvest not be undertaken on sites receiving vine control for at least three to five years following treatment. Additional monitoring should be conducted prior to harvesting and after initial grapevine treatment to see if additional treatment is needed for grapevine originating from sprouts and/or seed.

   Where existing grape arbors occur in areas designated primarily for wildlife habitat and commercial tree value is of lesser concern, some grapevine should be left intact since, in most cases, permanent damage has already occurred, and removal of all vines is not practical. Grapevines provide wildlife food and habitat. Careful consideration should be given to wildlife benefits when developing stand treatment prescriptions

   Herbicides may be used in application of this treatment. However, herbicide application is not necessary if crown shading from a well-developed closed canopy exists. In areas where canopy gaps or canopy openings exist and allow sunlight to reach the forest floor

herbicide may be needed for adequate control.

5. Crop Tree Release - Crop tree release is a pre-commercial silvicultural treatment applied to individual crop trees in immature stands. Crop tree management focuses on releasing individual trees that have been selected to produce benefits consistent with stand-specific objectives.

   The purpose of crop tree release is to accomplish stand specific landowner objectives that can be realized by increasing the growth rate of individual crop trees, and improving their quality and subsequent future value as a timber product, source of scenic beauty, or source of food and/or cover for wildlife.

   Crop tree release should be used in immature stands having a site index of 60 or better for northern red oak and having dominant or co-dominant trees at least 25 feet tall or at crown closure when adjacent trees form a forested canopy. Typically, 30 to 50 of the best dominant or co-dominant trees per acre should be selected as crop trees for release. Typically, crop tree release should remove all trees on three to four sides of the crop tree whose crowns are within six feet (horizontal distance) of the upper two-thirds of the crop tree's crown. In addition, adjacent trees further than six feet (horizontal distance) may be removed when they are significantly overtopping crop trees and have the potential to shade desirable crop trees and stunt their growth.

6. Midstory Removal – Midstory removal is the removal of trees within the midstory and understory of forested stands to increase the size and amount of desirable natural reproduction such as oak seedlings that require additional sunlight to grow. Under ideal conditions this practice should be followed by a planned harvest within 5 to 10 years after the midstory removal treatment in order to regenerate the stand with the developed desirable reproduction.

   The primary purpose of this practice is to remove the midstory and understory of forested stands, typically consisting of undesirable (shade tolerant) species to encourage the production of oak and other desirable seedlings and to increase their size and density so that oak and other preferred species can be a component of the future regenerated stand.

   This practice should be implemented in forested stands that lack adequate large advanced oak and desirable trees species reproduction (seedlings and saplings of preferred species greater than three feet tall). An adequate seed source and/or presence of seedlings of the desired species (e.g. oaks) must be present prior to implementation of midstory removal in order for the midstory removal practice to be effective in developing larger advanced reproduction.

   Stands selected for midstory removal should have a site index of at least 60 for northern red oak and have dominant and co-dominant trees at least 50 feet in height that form a closed canopy forest. Care should be taken not to create canopy gaps when removing the midstory in order to achieve optimal growth of oak seedlings and saplings in the understory. Oak seedlings will respond to increased sunlight in the understory (typically 20% full sunlight) after midstory removal, however the creation of canopy gaps will allow too much sunlight to reach the understory and will lead to increased growth in faster growing species such as red maple and/or yellow-poplar. Livestock must

   be excluded from the area. Oak trees must be adequately spaced within the treatment area in order to promote the production of oak seedlings.

Trees must be felled, receive herbicide injection (hack and squirt) or girdled and treated with an effective herbicide to prevent sprouting except for desirable species within the midstory and/or understory. Desirable species such as oak and hickory within the midstory and understory that have poor form and stagnant growth may be cut just above ground level and not treated with herbicide to encourage the growth of an aggressive stump sprout originating from the stump of desirable species.

7. Regeneration Release – Regeneration release refers to the removal of undesirable trees from an overstory after a harvest to release hardwood regeneration in the understory. This practice would be particularly effective in degraded stands within areas where a high-grade timber harvest has occurred within the last 5 to 10 years and where an understory of regeneration (seedlings 3 feet or more in height) has formed. The purpose of this practice is to remove or kill all undesirable overstory trees where they are inhibiting the regeneration from reaching the overstory within recently harvest stands. This does not include areas where there might be a combination of higher value overstory trees and little or no advanced reproduction. Care should be taken to conduct a detailed stand inventory and delineate areas of desirable regeneration in need of release from undesirable species left over from a previous timber harvest.

   The stand must have a site index of at least 60 for northern red oak or other desirable species representative of the site. This practice should be applied in stands where there is no more than 60 square feet of basal area. There should be an established understory in areas designated for release of large advanced reproduction (seedling and/or saplings of desired species greater than three feet tall) in which at least 25% of the seedlings and/or saplings are high quality hardwoods (e.g. oak, hickory, walnut, black cherry, cove hardwoods) by ocular estimate. All overstory trees 2“ DBH and larger need to be girdled and/or felled and herbicide applied where necessary to prevent re-sprouting of undesirable species. Livestock must be excluded from the area.

8. Combination Improvement and Free Thinning – Combination improvement combines the silvicultural treatments identified above such as cull tree removal, grapevine removal and free thinning in one stand when no one individual treatment is dominant. Free thinning is defined as the removal of trees to control stand spacing and favor desired trees, using a combination of thinning criteria without regard to crown position.

   This practice is to be used in immature stands and must have a site index of at least 60 for northern red oak and have dominant and codominant trees at least 50 feet in height. Stands must have a minimum of 20 crop trees per acre or potential crop trees that will benefit from treatment. Livestock must be excluded from the area.

Additional Criteria to Improve and Sustain Forest Health and Productivity

Treatments, including woody biomass removal, will be sustainable and will not compromise soil organic matter, the recruitment and retention of coarse woody debris, or wildlife habitat. If needed, use NRCS CPS 384, Woody Residue Treatment. If applicable, use biomass harvesting guidelines (The Forest Guild, 2010) and/or State guidance.

Manipulate stand characteristics to mitigate risk of insects and disease. Examples of stand manipulations include creating a diversity of tree species and a mosaic of age classes.

Additional Criteria to Reduce Fire Risk and Hazard and Facilitate Prescribed Burning

Reduce stocking rates and alter spatial arrangement of trees to minimize crown-to-crown spread of fire.

Use criteria for wildfire risk and damage reduction, including reduction of ladder fuels, in NRCS CPS Codes 383, Fuel Break; 384, Woody Residue Treatment; or 394, Firebreak, as appropriate.

Additional Criteria to Improve Wildlife and Pollinator Habitat

Manage for specific or a variety of cover types, species, size-classes, and stocking rates at the appropriate scale that meet desired wildlife habitat requirements.

Create, recruit, and maintain sufficient snags, nest, cavity, and den trees, and down woody material to meet requirements of desired species.

Use habitat creation and maintenance criteria in NRCS CPS Early Successional Habitat Development/Management(Code 647); Restoration and Management of Rare and Declining Habitats (Code 643) ; Upland Wildlife Habitat Management (Code 645); or Wetland Wildlife Habitat Management (Code 644) , as appropriate, to manage wildlife-related activities.

See Criteria for Area-Wide Thinning (Wildlife Management)

Refer to Upland Wildlife Habitat Management, Code 645, and Kentucky Wildlife Habitat Evaluation Procedure (KWHEP) for strategies to enhance or manipulate forest stands for wildlife.

For pollinator habitat maintain an open understory and encourage forest gaps or stand density that support diverse forbs and shrubs that provide pollen and nectar for pollinators. In addition, retain very early and early blooming flowering tree species during harvest activities, especially near edges of fields and openings. Refer to the Kentucky Pollinator Handbook for information regarding species and habitat for pollinators in forestry settings.

As a general rule thinned forest that allows for lighting of the forest floor and spacing of the midstory are better suited to wildlife including birds and bat species for foraging. Recommendations for thinning should create adequate tree densities for wildlife.

Additional Criteria for Forest Site Preparation for Natural Regeneration

The purpose of this practice is to remove or kill all undesirable trees that will inhibit regeneration from reaching the overstory within mature forested stands that will be harvested and to coppice desirable regeneration with poor form, health or vigor in order to develop a new cohort of desirable regeneration that will develop into young forest consisting of desirable species composition.

This involves the deadening of all unmerchantable and undesirable trees 1 to 3 years after or 1 to 3 years prior to a scheduled timber harvest by applying an effective herbicide to the cut stump surface or through hack n' squirt and/or girdling in order to remove undesirable species and unmerchantable trees that will interfere with the regeneration and recruitment of desirable reproduction (i.e. seedlings and saplings such as oak, hickory, walnut, black cherry). This practice consists of deadening all undesirable trees that are typically 2 to 12 inches DBH that will not be harvested in a scheduled timber harvest immediately following or just prior to a scheduled timber harvest. Desirable species such as oak and hickory within the midstory and understory of stands that where not harvested due to merchantability limitations that have poor form and stagnant growth should be cut just above ground level and not treated with herbicide to encourage the growth of an aggressive stump sprout originating from the stump of these desirable species.

The stand must have a site index of at least 60 for northern red oak or other desirable species representative of the site. There should be established reproduction in areas designated for treatment in the form of large advanced reproduction (seedlings and/or saplings of desired species greater than three feet tall) in which at least 25% of the seedlings and/or saplings are high quality hardwoods (e.g. oak, hickory, walnut, black cherry, cove hardwoods) by ocular estimate. In stands that lack desirable large advanced reproduction such as oak, a midstory removal treatment should precede the pre-harvest site preparation for natural regeneration treatment and scheduled overstory timber harvest by five to ten years to encourage the growth of large advanced reproduction that will grow into the next stand following the scheduled timber harvest. Livestock must be excluded from the area.

Herbicide recommendations for deadening of trees that are more vulnerable to sprouting after cutting may be obtained from the UK Cooperative Extension Service, the Kentucky Division of Forestry, Kentucky Department of Fish and Wildlife Resources (KDFWR) or approved TSP.

Success of this treatment is determined by monitoring the stocking of desirable regeneration within five years after the final regeneration harvest and the associated site preparation treatment. The newly established regeneration should meet a minimum stocking of 150 desirable hardwood species per acre. When the management objectives are for the establishment of yellow pine dominated forest types minimum stocking should consist of desirable species of at least 300 yellow pine or yellow pine-hardwood seedlings. This standard applies to all types of silvicultural systems where the stand is regenerated, and a new cohort is established.

Note that this practice may be planned in conjunction with Tree/Shrub Site Preparation (Code 490). For areas that have minimal to no woody species and are approximately 5 acres or less utilize CPS Tree/Shrub Site Preparation (Code 490).

Additional Criteria to Alter Quantity, Quality and Timing of Water Yield

Create a mosaic of age classes to increase water yield and stabilize seasonal water yield from watersheds.

Create openings in the forest canopy to allow more light to reach the ground, stimulating understory vegetation and diversifying plant species composition and vertical structure. These improvements will increase rainfall infiltration and reduce runoff thereby reducing soil erosion and improving water quality.

Additional Criteria to Increase Carbon Storage

Manage for tree species and stocking rates that have higher rates of growth and potential for carbon sequestration.

CONSIDERATIONS

Considerations for Wildlife and Pollinator Habitat

State Wildlife Habitat Guidelines, Wildlife Habitat Evaluation Procedure, and Forestland Assessment Scorecard are useful tools in planning forest stand Improvement.

Consider removing vines from crop trees but retaining vines with wildlife value (e.g., grape and poison ivy) on noncrop trees.

Increase quantity and quality of important mast (seeds, catkins, fruits, and nuts) sources for

wildlife through crop tree management and other techniques.

Improve horizontal diversity or patchiness (of different age class units) across the forest for a variety of wildlife.

Improve or maintain vertical structure or vegetative layering in treated stands.

Favor declining wildlife species by providing appropriately sized treatment areas or blocks of habitat.

Time forest stand improvement activities to minimize disturbance of seasonal pollinator and wildlife activities, such as nesting, movement, etc.

Considerations for Improving and Sustaining ForestHealth and Productivity

Consider crop tree management (Perkey et al. 1994) when making decisions about which trees to retain and which to cut, kill cut, or kill.

If available use sanitation-salvage and risk-rating criteria to determine trees to remove during forest stand improvement operations (see Thinning and Sanitation in Donaldson and Seybold 1998).

Silvicultural objectives and harvest-regeneration strategies may change over time and may be limited by prior management.

Consider enlisting the assistance of a professional forester when seeking to rehabilitate degraded stands that have been repeatedly subjected to exploitative harvesting (highgrading). Often a complex site- specific treatment plan must be developed to overcome repeated exploitative timber harvest.

Successful regeneration of desirable species is usually dependent upon timely application of forest stand improvement and other practices. Consider the need for complimentary practices such as CPS Access Control (Code 472), Fence (Code 382) and Prescribed Grazing (Code 528) to exclude livestock and protect forestry resources. To augment forestry species diversity and enhance wildlife resources consider complimentary practices such as Tree/Shrub Planting (Code 612) and Tree/Shrub Site Preparation (Code 490).

Where appropriate and feasible consider the use of CPS Prescribed Burning (Code 338) to enhance communities and restore natural ecosystems (e.g. shortleaf pine ecosystems). Refer to CPS Restoration of Rare or Declining Communities (Code 643) for communities that may benefit from prescribed burning.

The extent, timing, size of treatment area, or intensity of the practice application, should be adjusted to minimize cumulative effects (onsite and offsite), such as hydrologic and stream alteration, habitat fragmentation, nutrient cycling, biodiversity, and visual resources.

Consider retaining at least 1/4 to 1/3 of the slash, tops, and limbs after harvest to protect site productivity. When using whole-tree harvesting systems minimize the removal of needles or leaves by harvesting in the dormant season, retaining fine woody materials onsite, or leaving felled trees onsite to allow for needle or leaf drop.

Consider controlling invasive plants if they are encountered while conducting forest stand improvement. Use NRCS CPS Codes 314, Brush Management; or 315, Herbaceous Weed

control, as appropriate.

When available, report the minimum criteria (diameter at breast height, log length, etc.) for commercial forest products (sawtimber, pulpwood, etc.) in order to know when to direct a client to a professional forester.

Consider advising landowners to secure a written contract with a service provider that specifically describes the extent of activity, duration of activity, liability and responsibilities of each party, and amount and timing of payments for services provided.

Considerations for Increasing Carbon Storage

To increase carbon storage, consider shifting from even-aged to uneven-aged management to increase the retention of carbon onsite. Use regeneration methods that encourage advanced regeneration and retention of mature trees, such as shelterwood, to retain carbon onsite for longer periods. Consider retaining snags and downed woody debris for additional onsite carbon storage, and adopt techniques for maintaining soil quality, including organic carbon retention.

To grow trees that can store carbon in durable manufactured products, consider lengthening rotations to retain mature trees longer and grow to larger sizes; also consider using crop tree management techniques (Perkey et al. 1994) to concentrate growth on suitable long-lived species.

Considerations for Visual Quality and Safety

When forest stand improvement is being used to improve visual quality consider leaving trees that are attractive in shape and structure or flower and are appropriate to the site, especially around structures, roads, and home sites.

Consider the hazards caused by the creation of standing dead timber and utilize precautions to avoid being injured or killed by falling trees.

PLANS AND SPECIFICATIONS

Plans and specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, implementation requirements (job sheets), technical notes, and narrative statements in the conservation plan, or other acceptable documentation. Clearly state the goals and objectives of the forest stand improvement. Specific stand-stocking guidelines will clearly document both the pre- and post-treatment stand condition.

At a minimum the following will be identified:

- Landowner objectives
- Type of treatment
- Treatment acreage / orientation
- Treatment location
- Existing conditions
    - Preferred tree and understory species
- Expected outcomes
- Treatment specifications

- Spacing, density, size class, number and amounts of trees and understory species to be retained
- Stocking guidelines shall contain stocking in terms of basal area, spacing or trees per acre by species and size class distribution.
- The harvest-regeneration strategy will be identified for all planned forest improvement harvesting:
  - Uneven-aged management systems (e.g.,group selection)
  - Even-aged management (e.g., clear-cut, seed-tree, shelterwood, coppice)

- Treatment dates
- Operation and maintenance plan

OPERATION AND MAINTENANCE

Prepare an Operation and Maintenance plan for the site and review it with the operator. The plan will describe actions that must be taken to ensure that the practice is applied correctly during its design life. As a minimum, include periodic inspections for assessment of insects, disease, and other pests, storm damage, and damage by trespass. Use NRCS CPS Code 655, Forest Trails and Landings, to control erosion on forest roads, skid trails, landings, and adjacent areas by installing/maintaining vegetative and structural practices. Treatments needed for pests—see Additional Criteria to Improve and Sustain Forest Health and Productivity section in this document. Treatments needed for storm damage—use NRCS CPS Code 384, Woody Residue Treatment, to appropriately treat slash and debris. Treatments for damage by trespass: use NRCS CPS Code 472, Access Control, to prevent future damage.

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