Tank 16H Grout Strategy

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1.0 Summary

Waste has been removed from Tank 16 to the maximum extent practical from an engineering perspective. The majority of the residuals are located in the annulus. Residuals have been sampled and are in the process of being characterized, and Tank 16 is being isolated from the H-Tank Farm (HTF) facilities.

Upon agreement from the Department of Energy (DOE), South Carolina Department of Health and Control (SCDHEC), and Environmental Protection Agency (EPA) that all HTF General Closure Plan (7.1) requirements have been met, the project will proceed with stabilizing the tank with grout. This strategy will outline the Tank 16 grouting process.

2.0 Grout Functions, Requirements, and Formulation

Liquid waste tanks undergoing closure are required to be filled with grout for the purpose of stabilizing residual material, filling the tank void space, and discouraging future intrusion. Filling a cleaned waste tank with grout also protects the walls and ceiling from possible collapse thereby providing long-term stability.

The supplier selected to provide grout for Tank 16 will be required to demonstrate the ability to batch and deliver the flowable, structural fill to HTF. Samples of material batched at full-scale will be tested to qualify the ability of the grout subcontractor to produce and deliver the mix. The procurement specifications for Tank 16 bulk fill and coil fill grout are the same specifications (7.10 and 7.14) as the ones used for grouting Tanks 5 and 6. The equipment fill grout will meet the requirements as stated in Reference 7.22.

3.0 Pour Methodology

A supplier will deliver bulk fill grout to a Savannah River Remediation (SRR) installed-and-operated grout distribution and placement system. The grout will be delivered to HTF using cement mixer trucks. The cement mixer trucks will empty grout into grout pumps located southeast of Tank 16. The grout will be pumped from the grout pump through slicklines to multiple primary tank and annulus risers on Tank 16. Lessons learned from previous tank closures identified the benefit of a minimal time gap between grout trucks during select lifts in the annulus and the primary tank. The grout delivery contract does not have a required delivery frequency specified in the contract; however, early communications with the grout supplier during these critical placements ensures that we have the correct number of vehicles in the rotation to be successful. While the optimal number of vehicles for these select placements will vary from tank to tank (due to route length and personnel interaction) SRR has identified an ideal range to be approximately 8-10 trucks.

The grout distribution and placement system will be slicklines configured to support primary or annulus filling as required. The slickline routing to individual risers will be

implemented using slickline fittings (e.g. tees and elbows). The slicklines, routed to minimize their length, will be compliant with American Society of Mechanical Engineers (ASME) B30.27-2009, *Material Placement Systems*, (7.12) and American Concrete Institute (ACI) 304.2R-96, *Placing Concrete by Pumping Methods* (7.13 & 7.19).

Bulk fill reducing grout will be used to fill to the extent practical the volume of both the primary tank and annulus of Tank 16, including the annulus ventilation duct volume. The bulk fill reducing grout will flow and cover any residual material remaining in the tank and annulus. The grout used for Tank 16 meets the PA requirements (i.e. segregation, compressive strength, and hydraulic conductivity). If additional pour locations are required to cover tank residual material, additional access points will be identified and slicklines installed to address the exact area requiring special effort. Tank Risers 2, 3, 6, 8, and Annulus risers West, and East are the typical grout pour locations as shown in Figure 3.1.

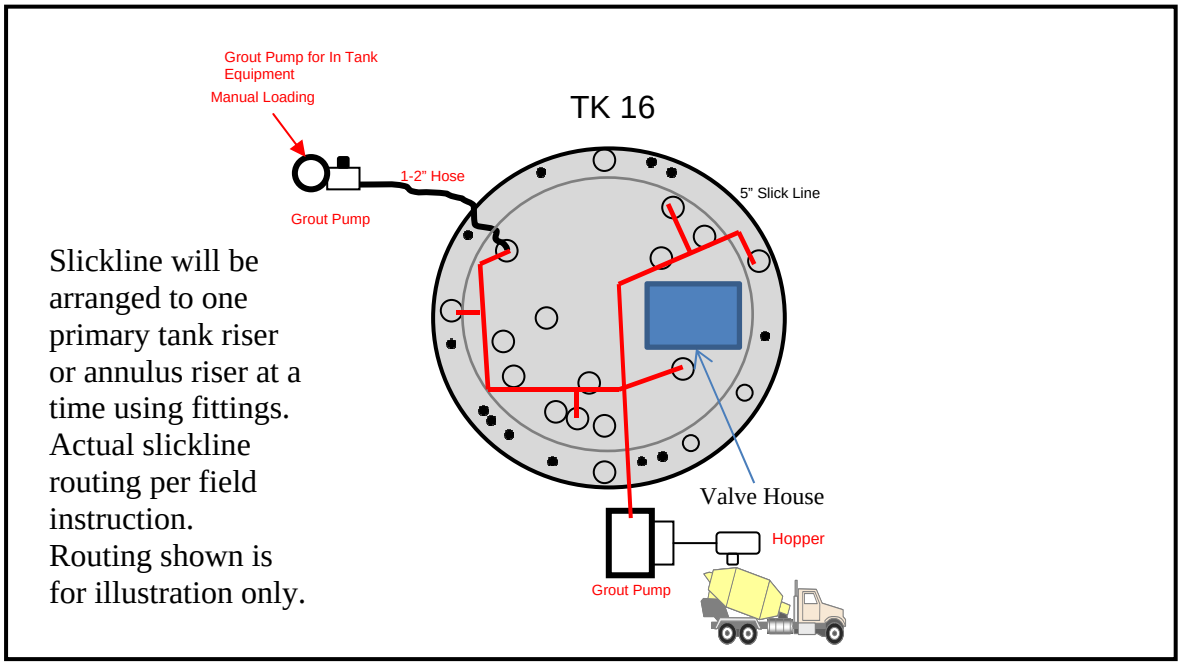

Figure 3.1: Tank 16 Typical Grout Equipment Layout

4.0 In-Tank Equipment

4.1 Overview

Various types of equipment from the bulk waste removal and heel removal campaigns remain in Tank 16. The goal of in-tank equipment grouting is to eliminate vertical fast flow paths down through the grout to the residual material on the tank floor. A vertical fast flow path negates two of the primary purposes of the entire grouted tank:

1.) Slow water infiltration and
2.) Chemically treat the infiltrating water to retard contaminant migration.

Any open vertical pathways (e.g. pump discharge lines, thermowells, etc.) in the tank will be filled with grout to the extent practical. The equipment fill grout mix (7.22) will be used for the filling of abandoned equipment. Tables 4.0-1 and 4.0-2 show the equipment remaining at the start of grouting in Tank 16 and the locations. Equipment to be grouted in the tank is listed in sections 4.2-4.14. To ensure the grouting will meet the Performance Assessment (PA) assumptions in Ref 7.2, successful grouting of the internals of the dip tubes and other open ended equipment requires grouting activities to be performed in the correct order. Vertical pipes open at the bottom, such as dip tubes, must have the bottom open end of the pipe covered by bulk fill grout before they are grouted. The cooling coils will be discussed in section 5.2.3.

Due diligence will be used to add the equipment fill grout into the equipment to ensure that voids are filled to the extent practical. Visual or volume verification will be used to ensure equipment and risers are filled to the extent practical. Smaller items are generally considered negligible with respect to post-closure performance of waste grout. (7.3) Specific smaller piping and equipment should be documented to demonstrate that efforts were made to grout equipment to the extent practical. The void space associated with the equipment remaining in the tank will be accounted for in the internal equipment evaluation (7.15) All efforts should be made to vent equipment being filled with grout.

Table 4.0-1: Remaining Tank 16 Primary Equipment at Start of Grouting

Riser	Riser Equipment Status After Isolation	Work Required Before Grouting	Grout Plan
1	Duct installed from Riser 1 to IP-154. Grating over the riser.	Fabricate and install ventilation spoolpiece/duct.	Riser 1 will be used as a primary ventilation exhaust system and the 6'' port will be utilized to grout the riser.
2	Spray wash chamber. Grating around spray wash chamber.	Fabricate a Grout Riser cover plate from P-PM-F-00326.	Grout spray wash chamber.
2a	Transfer pump with thermowell and spray chamber. Grating around the riser.	Install grout connections	Grout fill pump, spray wash chamber, and thermowell.
3	Spray wash chamber Grating around spray wash chamber Robotic Sampling Crawler New plate installed from sampling (Sketch 125627)	Install grout connections	Entomb crawler and grout spray wash chamber.
4	Inhibited water line installed through riser cover. Rotary spray jet assembly installed. Grating covers riser.	Fabricate and install ventilation spoolpiece/duct.	Tank secondary ventilation outlet system. Grout fill flush water line and rotary spray jet.
4a	Spray wash chamber and Rotek. Grating around riser.	Install grout connections	Fill spray chamber through its side port.
5	Medium steam line, Hydrogen Monitor, 1'' Pipes, and thermowell	Install grout connections	Primary ventilation inlet system. Grout fill the medium steam line, hydrogen monitor, 1'' pipes, and thermowell.
6	Spray wash chamber Grating around spray wash chamber Robotic Sampling Crawler New plate installed from sampling (Sketch 125627)	Install grout connections	Entomb crawler and grout spray wash chamber.
7	Inhibited water line installed through riser cover. Rotary spray jet assembly. Grating covers the riser.	Install grout connections	Grout fill the Inhibited water line and rotary spray jet. Grout fill through existing 7.5'' Port
8	Spray wash chamber Grating around the spray wash column New plate installed from sampling (Sketch 125627)	Install grout connections	Grout spray wash chamber.
3'6"	Overhead piping obstruction Steel Beams and Grating covers riser 4'' flex duct underneath riser HLLCP, Reel Tape, and Dip Tubes are abandoned in place.	Install grout connections	Grout fill HLLCP, Reel Tape, and dip tubes.
HV	HV System electrically isolated. Demister installed.	D&R riser cover and install new grouting riser cover	Grout through HV Riser and entomb demister.

Table 4.0-2: Remaining Tank 16 Annulus Equipment at Start of Grouting

Riser	Riser Equipment Status After Isolation	Work Required Before Grouting	Grout Plan
N	None	None	Primary Ventilation Outlet
W	None	D&R existing plate and install new grouting plate per P-PM-F-00326.	Bulk fill grout through new grout plate.
E	None	D&R existing plate and install new grouting plate per P-PM-F-00326.	Bulk fill grout through new grout plate.
S	None	None	Primary Ventilation Inlet
IP-18	None	Raise plug, install shim and grout connections.	Grout fill IP Port
IP-35	None	Raise plug, install shim and grout connections.	Grout fill IP Port
IP-39	Thermowell installed and attached to IP port plug	Raise Thermowell, install shim and grout connections.	Grout fill thermowell.
IP-42	Bubbler installed	Raise Bubbler, install shim and grout connections.	Grout fill bubbler.
IP-65	Transfer jet installed and cannot be removed	After the first lift in the annulus, Transfer jet bolt will be cut to lower the jet to the bottom of the tank.	Grout fill through vacant bolt hole to entomb transfer jet.
IP 182	None	Raise plug, install shim and grout connections.	Grout fill IP Port
IP-118	None	Raise plug, install shim and grout connections.	Grout fill IP Port
IP-154	Duct installed from Riser 1 to IP-151. 1'' tube installed to the bottom of the annulus.	Install grout connections	Grout fill IP Port
IP-151	None	Raise plug, install shim and grout connections.	Grout fill IP Port
IP-207	None	Raise plug, install shim and grout connections.	Grout fill IP Port
IP-259	1'' Pipe	Raise plug, install shim and grout connections.	Grout fill 1'' pipe and IP Port
IP-262	None	Raise plug, install shim and grout connections.	Grout fill IP Port
HV Supply	Annulus Fan and duct work	Remove flange and install side wall grout plate.	Grout through the side plate to grout the duct.
HV Exhaust	Bolted Flange with HEPA filter assembly	Remove Flange and HEPA. Install side wall grouting plate.	Grout through the side plate.

4.2 Riser 2a Transfer Pump

The transfer pump and thermowell in Riser 2a will be grouted internally with equipment or cooling coil grout, through the flush connection in the upper riser and its discharge line. The vent line will also be utilized to fill the remaining riser with grout. The bottom of the pump must be covered in bulk fill grout prior to the introduction of grout into the pump. The spray chamber will remain in place and grouted with the transfer pump and thermowell.

4.3 Spray Chambers

Equipment in Tank 16 will be filled internally with equipment grout. The spray chambers remaining on Tank Risers 2, 2a, 3, 4a, 6, and 8 extend beyond the top of the riser and are secured to the 4' high structural steel grating. Due to their configuration with the structural steel, the spray chambers will be grouted in place. Visual inspection or volume verification is required to ensure grout reaches grade level inside the spray chambers. The spray nozzles and its associated spray ring are ¾'' SCH 40 pipe extending about a foot into the riser. They will not require grout due to their small diameter and not being a vertical fast flow path.

4.4 Robotic Crawlers

Two electrically powered sampling crawlers, from the sampling effort, will remain in the tank. The robotic sampling crawlers will not require internal grouting due to their lack of internal void space. (7.3) Cabling attached to the sampling robot has been cut and dropped to the tank floor. The cabling is not required to be moved from its current arrangement in the tank. The sampling robots will be entombed in place on the tank floor. The potential for galvanic corrosion of the carbon steel tank floor due to the presence of stainless steel equipment was evaluated (7.5) and found to be negligible.

4.5 Riser 1 and IP-154

A 10'' ventilation duct runs from Riser 1 to IP-154. The horizontal section of this duct will be removed and a ventilation system will be installed using the existing ductwork in Riser 1 and IP-154. In IP-154 1'' tygon tubing extends to the bottom of the annulus. Due to ALARA and exposure concerns, the tygon tubing will remain in the tank and is expected to collapse during grouting operations eliminating it as a fast flow path. Riser 1 plug will be utilized to grout fill the remaining riser 1 void space.

4.6 3'6'' Riser Equipment

There is a 4'' flex duct, reel tape, three dip tubes, and an HLLCP (High Liquid Level Conductivity Probe) in the 3'6'' Riser. The 4'' flexible duct on the bottom of the tank will be entombed in bulk fill grout. The flex duct is similar to a tremie and will be

similarly allowed to remain in the tank and to be entombed in grout per Ref 7.3. The HLLCP will be cut and lowered into the tank. The reel tape, three dip tubes and the remaining HLLCP housing will be grouted in place.

4.7 Risers 4 and 7

Riser 4 and 7 contains an abandoned IW (Inhibited Water) line and a rotary spray jet assembly. The abandoned IW line and rotary spray jet will be grouted in place. The rotary spray jet has small void spaces that cannot be practically filled due to its configuration. Riser 4 will also contain the secondary ventilation outlet. The Riser 7 plug will be utilized to fill the remaining riser void space. After completion of bulk fill, Riser 7, a degraded riser, will be skirted with grout to minimize water intrusion. (7.17)

4.8 Riser 5

Riser 5 has a medium steam line, thermowell pipe, and a hydrogen monitor connection. The medium steam line extends into the tank about 10 feet below the riser while the thermowell pipe extends to the bottom of the tank. The medium steam line, hydrogen monitor, and thermowell pipe will be filled with equipment grout. Riser 5 will be used as the primary ventilation inlet.

4.9 H&V Riser

The H&V riser contains a demister that rests inside the riser and extends to the top of the tank. The demister will remain inside the H&V riser and grouted in place.

4.10 IP-39 Thermowell

The thermowell in IP-39 is secured to its port plug and extends to the bottom of the annulus. It will be filled internally with equipment grout.

4.11 IP-42 Bubbler

An isolated level detection bubbler is in IP-42 that extends to the bottom of the annulus. The bubbler will be filled internally with equipment fill grout to the extent practical.

4.12 IP-65 Transfer Jet

IP-65 contains a transfer jet that cannot be removed and is suspended from the underside of the riser cover. Due to its configuration, (cannot be removed practically) the transfer jet support bolt will be cut after the first lift in the annulus, allowing the jet to rest on the tank bottom. The vacant bolt hole will be utilized to fill the IP.

4.13 IP-259 Pipe

The riser plug for IP-259 contains an isolated 1" diameter pipe which extends into the annulus vapor space. The pipe will be filled internally with equipment fill grout to the extent practical.

4.14 IP Plugs

The IP plugs will be raised and shimmed to support grouting of the inspection port void spaces. The only IP ports not requiring shims are IP-65 and IP-154. Instead of shimming these two IP ports, a minimum of 3 inches of grout will be placed over them. (7.17)

5.0 Grout Strategy

5.1 Pre-Grout Activities

The preferred risers for Tank 16 grout additions are Tank Risers 2, 3, 6, 8, and annulus risers West, and East. The risers are adequately spaced to allow for grout to be spread throughout the four quadrants of the tank. These risers will be modified to permit grout to be placed into the tank and have no known internal obstructions. For Tank 16, it is assumed that Risers 2, 3, 6, 8, East, and West riser plugs will be replaced with riser covers to support grouting. The slickline has been evaluated against ACI 304.2R per reference 7.19.

The Tank 16 primary purge ventilation system is isolated (7.8) and cannot be used. A temporary ventilation system will be provided in both the primary tank and the annulus for radiological control. These ventilation systems will easily provide enough flow to maintain a non-flammable vapor space per NFPA 69. In the case of the primary region of Tank 16, Riser 5 has been assigned the role of ventilation inlet, while Risers 1 and 4 will act as the ventilation outlets. In the annulus region, the South Riser will be used as the ventilation inlet, while the North Riser will function as the outlet. IP-151 will have a backup ventilation system in case of the North riser system failure. The primary exhaust ventilation trains are redundant and in this way, no adverse impact to grouting operations will occur if the HEPA (High Efficiency Particulate Air) filters need replacing. The exhaust ventilation for the annulus is not redundant and is an acceptable risk based upon no previous HEPA filter failures during grouting. In addition, the time to fill the annulus is significantly less than the time to fill the primary tank thereby further reducing the risk of HEPA filter failure on a single annulus exhaust train. The system will have provisions (e.g., demister) for dealing with moisture in the vapor.

The guidance provided in the Flammability Control Program Description Document (7.9) will be followed for NFPA 69 compliance (7.11) once grouting commences. It is recommended to reduce ventilation system operation between grout placements in the

annulus to maintain a moist environment. However, vapor space sampling for NFPA 69 compliance will still be followed and may require the ventilation to be operational.

Provisions will be made to provide grout delivery point(s) into the tank, provide camera and lighting access into the tank, provide containment, manage air displacement, manage ventilation condensate, and handle any overflow while filling equipment, the tank/annulus, and void spaces or risers. Figure 3.1 shows a typical slickline path and riser installation concept. Risers 2, 3, 6, 8, West, and East will be configured to support video operations.

Grout distribution piping, slickline, and tremie (i.e., hose used to reduce the drop height of grout into the tank) details will be included in the installation work packages. All equipment modifications inside the tank isolation boundary will be detailed accordingly via field sketches that will be utilized during pre-grout and grouting activities (7.6). Modifications to the grout distribution piping, slickline, or tremie that deviate from the field sketch shall be approved by Engineering to ensure code compliance. The distribution piping will be inserted through one or more riser access port(s) to allow introduction of the bulk fill grout into the tank. The distribution pipe outlet may have the ability to traverse, allowing limited directional control of the grout leaving the distribution piping. The distribution piping may be able to move within the riser opening and to another riser when needed. This additional movement can alleviate the possibility of grout forming a mound under the pour location.

The project team will develop detailed grout modification work packages for each riser. Bulk fill grout will be introduced into the annulus space of the tanks using two of the four annulus risers. The two annulus risers used to place grout will be at approximately opposite ends of the tank. Two large annulus risers or nearby IP's shall be configured to support simultaneous camera operation. Two annulus risers shall be configured to support a portable ventilation system configured similarly to the tank primary portable ventilation.

5.2 Grout Sequencing Activities

The sequence of primary tank and annulus filling is subject to the restrictions imposed by Structural Integrity requirements (7.18).

Each day of grout placement in the primary tank or the annulus, a camera inspection shall be performed prior to start of pouring grout. These inspections will look for voids or anomalies in the grout placed the previous day. Additional camera inspections are recommended during grout pouring at approximately midday and at the end of the day when grout pouring is complete for the day. These inspections shall be recorded. However, grout filling may proceed without an operating video camera, as long as the initial camera inspection of the day is completed. The grout level will be calculated based on the volume of grout added and verified using visual reference markings, as possible.

5.2.1 Annulus Bulk Fill Grouting

Bulk fill grout will be introduced into the annulus via tremie hose at the East and West risers. The duct is already supported by material and has numerous holes. An initial bed of grout to support the annulus duct is not necessary. The duct also contains material which could block grout additions into the duct. Therefore, initial filling of the duct through the ventilation inlets will not be required. The duct will be filled to the extent practical after completion of bulk fill grout in the annular space.

The addition of bulk fill grout into the rest of the annular space is subject to the restrictions imposed by Structural Integrity requirements (7.18), up to the annulus riser openings. The lower portion of the ventilation duct will fill through the open registers during bulk fill. The vertical sections of the annulus ventilation inlet and exhaust ducts will be filled all the way back to grade level with bulk fill grout. Neither duct should be filled until the rest of the annulus filling is completed. There is no requirement to cap the annulus ventilation duct at grade level.

5.2.2 Primary Bulk Fill Grouting

Grouting of the primary tank will begin prior to the grouting of vertical cooling coils. Primary tank filling is subject to the restrictions imposed by Structural Integrity requirements (7.18).

Multiple risers may be used to place grout into the primary tank. Field experience and engineering judgment shall dictate from which riser to fill and the frequency of of which risers are switched.

The in-tank equipment may be filled with grout when the bottom open sections of the individual pieces of in-tank equipment are determined by visual surveillance to be covered by bulk tank fill grout. During the bulk fill grouting activities of the tank, the tank will be ventilated utilizing a portable ventilation system.

5.2.3 Cooling Coil Grouting

The bulk grout fill level in the tank shall be adequate to support the coils during grout filling but shall be limited to a level that maximizes the potential to allow guillotined coils to vent. The bed of grout will support the vertical cooling coils, help prevent vertical coil failure during grouting, and prevent tank roof collapse due to shell buckling during grouting. Engineering judgment shall be used in determining when required grout depth has been reached. Limiting the grout level will provide the greatest opportunity for guillotined cooling coils to vent during grouting, while providing adequate structural support.

The cooling coils containing chromate water will require a one volume flush prior to grouting. All intact cooling coils are flushed once prior to the introduction of grout back into another active waste tank. All intact cooling coils and cooling coils with pinhole

leaks shall be grouted from the inlet and the volume of flush water displaced from the coils by grout shall be returned to another waste tank. This volume will be determined visually. When grout is visually detected at the cooling coil outlet, additional grout shall be introduced into the cooling coils to ensure the coil is filled past the interface layer as determined in reference 7.7 and 7.21. The grout/flush water interface volume will be collected and disposed of separately.

Coils having a guillotine failure shall be grouted from each end until indicated to be full. It will not be possible to collect any residual water from these types of coils during the grouting. There may be sections of coils with guillotined breaks not connected to the coil inlets and/or outlets. These intermediate sections of coils with guillotined breaks may not be filled with grout internally due to their configuration.

5.2.4 Tank Riser Grouting

The twelve primary tank and eighteen annulus risers to be filled are listed in Table 4.0-1. All risers have a cylindrical upper portion that reduces down to a smaller diameter cylinder, capped by a riser cover. Risers will be properly ventilated during the riser filling process. Individual risers may be capped with bulk fill grout, 5000 psi concrete, or other suitable material. Inspection Port (IP) covers can be capped with the use of a 3'' Sonotube. (7.17) Risers or other tank penetrations extending to above the grade level will not require capping if the grout level in the riser or penetration also extends above the grade level. The grout level in these risers or penetrations will be brought to the level of the riser opening. This level of grout combined with the riser cover will minimize potential water intrusion. Riser capping activities will be performed per the requirements of NFPA 69 as described in Ref 7.11 or another engineering approved strategy. In those risers or tank penetrations where bringing the grout level to above the grade level is not achievable, a grout cap shall be placed greater than or equal to the height of the void. Grouting of penetrations, such as tank and annulus risers, is considered adequate at the point that the grout covers the top of the riser. (7.17) This level of grout/material combined with the riser cover will minimize the potential water intrusion. The HV riser will have a grout plate installed. Grout will flow through this grout plate and fill the HV riser including its three pipe legs and demister to the extent practical. Any exceptions to this section will be evaluated in similar manner as reference 7.4.

6.0 Conclusion

The current approach to closing Tank 16 is to fill the tank with a chemically reducing cementitious grout that is capable of protecting against inadvertent intrusion after closure. The Tank 16 project team has designed the Tank 16 grouting strategy for planning purposes. This Strategy may be revised as detailed planning of the specific grouting implementation activities progresses.

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