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Staff Supplement to CASE Report #2016-RES-DHW1-F

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Subject: Residential Instantaneous Water Heaters 2016-RES-DHW1-F

DESCRIPTION OF PROPOSED REGULATORY CHANGES

CASE report #2016-RES-DHW1-F titled Residential Instantaneous Water Heaters, proposes to make the following changes to the Standards:

- The CASE proposal recommends new requirements for isolation valves for instantaneous water heaters in Section 110.3(c)7. This requirement will assist with the flushing of the heat exchanger, which will extend the lifespan of the water heater and allow the unit to operate at peak efficiency, thereby minimizing the energy use for both residential and nonresidential buildings.

- The CASE proposal also recommends changing the prescriptive requirements for water heating in newly-constructed single-dwelling units in Section 150.1(c)8A. The proposed prescriptive requirement can be met by either the installation of an instantaneous water heater, or a storage water heater with Quality Insulation Installation (QII) plus either compact hot water distribution system or field verified pipe insulation. These requirements will cost-effectively increase the stringency of the Standards, while maintaining flexibility, thereby minimizing the energy use of newly-constructed single-dwelling units.

- The CASE proposal recommends deletion of section 150.1(c)8D. There is no evidence that this option was ever used and this will simplifying the number of prescriptive water heating options.

- The CASE proposal recommends clarifying language to section 150.2(b)1G related to natural gas availability to the building.

Staff agrees with the recommended changes to Sections 110.3(c)8, 150.1(c)8D and has incorporated substantively similar changes into the proposed Express Terms.

Staff does not agree with the recommended changes to Section 150.1(c)8A and 150.2(b)1G, and have instead proposed to make the following changes to Section 150.1(c)8A and 150.2(b)1G in the Express Terms.

- Modify the CASE proposal for the prescriptive alternative for storage water heaters to apply to tank sizes equal to or less than 55 gallons. While not explicitly stated in the proposed language in the CASE report, the analysis was done using an equal to or less than 55 gallons storage gas water heater that meets the federal minimum standard.

- Provide an additional prescriptive alternative for a storage water heater over 55 gallons plus either compact hot water distribution system or field verified pipe insulation. This change will recognize the more stringent minimum efficiency requirement for storage water heaters larger than 55 gallons by eliminating the requirement for QII. This additional option will provide more flexibility while maintaining energy equivalency to instantaneous water heater.

- Make clarifying language to section 150.2(b)1G relating to pipe insulation requirement for replacement water-heating systems and allow recirculation systems to be installed if it is a demand system with manual control pumps. This change makes the requirement consistent with the requirement for newly constructed buildings.

STAFF ANALYSIS AND CONCLUSION

Staff has analyzed the submitted CASE report and reached the following conclusions for the measures included in the Express Terms:

- Based on the evidence presented in the CASE Report, the measures, as proposed, are cost effective and the author has appropriately followed the Energy Commission's Life Cycle Cost methodology.

- Measure costs premiums presented in the CASE Report are reasonable and appropriate for the measure proposed.

- Measure energy savings presented in the CASE Report appear to have been appropriately modeled and are credible.

- Measure environmental impacts presented in the CASE Report are reasonable and appropriate for the measure proposed.

Staff additionally agrees with the water heater lifespan and maintenance schedule used for the LCC analysis for the following reasons:

The consequences of a lack of maintenance are significantly different for instantaneous and storage water heaters. In addition, local water quality has a significant impact on how severe the consequences are in each circumstance.

In the case of instantaneous water heaters, a lack of maintenance will lead to a gradual build-up of scale (calcium carbonate) at the heat exchanger, which reduces the rate of heat transfer to the water and therefore the efficiency of the water heater. The speed of the build-up depends heavily on the hardness of water, where higher hardness corresponds to faster scale build-up. As this occurs, the end user receives feedback that maintenance needs to be performed, as the temperature of the delivered hot water declines over time. Additionally, the majority of instantaneous water heaters currently on the market have a controller able to detect the degradation in heat exchanger performance and give users a warning to perform maintenance, and are further able to lock operation to prevent permanent damage to the heat exchanger if the scale build-up becomes too severe. De-scaling the heat exchanger restores both the performance and efficiency of an instantaneous water heater to nearly its original level.

In the case of the storage water heaters, sediment in the water tends to sink and accumulate at the bottom of the tank. This accumulation can lead to overheating of the tank material as the buildup acts as an insulator between the tank burner and the water. This, in turn, causes heat buildup at the bottom of the tank during recovery, which can cause the glass lining to dissolve, degrade the steel and welds, and expose the tank to corrosion. Since the burner surface at the bottom of the tank cannot be completely cleaned, regular flushing to prevent sediment buildup is the only way to limit the decrease in efficiency and prolong the lifespan of the tank.

Although sediment buildup affects the efficiency of the water heater, because a storage water heater will continue to heat water until the water in the tank is restored to its setpoint temperature this loss of efficiency is generally invisible to the user: the temperature of delivered water remains the same while recovery time increases. The failure mode of storage water heater is therefore dramatically different from instantaneous water heaters and can result in catastrophic failure and water damage to the home. An assessment by the Insurance Institute for Business & Home Safety (IBHS 2007) found that storage water heater failures cost average of $4444 per incident, and 69 percent of water related loss claims were due to leaking or bursting of the water tank. The user is unlikely to receive feedback that the sediment buildup is occurring or tank failure is imminent unless regular flushing and inspection of the anode rod is performed.

In cases of extremely hard water, artificial water softening equipment might be installed. In this situation storage water heaters will require additional maintenance compare to instantaneous because of the increase in anode corrosion due to the artificial water softening (requiring, at a minimum, more frequent inspection of the anode rod). Anode rod condition, like sediment buildup, is generally invisible to the user as it does not result in any feedback in terms of water heater performance.

For the above reasons, the maintenance demands and lifespan for both instantaneous and storage water heater can depend heavily on water quality. Staff has therefore determined it is reasonable to expect performance of regular maintenance as presented in the CASE report for the expected lifespan of 13 years for storage water heaters and 20 years for instantaneous water heaters.

It should be noted that staff received comments requesting the delay of this proposal due to the new Federal Water Heater testing procedure and the associated complexity in integrating the new

efficiency descriptor Uniform Energy Factor (UEF) into the performance calculation. While staff acknowledged that these changes are underway, they are unrelated to the current proposal. The proposal does not include specification of UEF values, but states only that installed water heaters must comply with applicable appliance efficiency regulations.

The Department of Energy is obligated to conduct a rulemaking proceeding to develop factors that will convert the federally mandated Energy Factor into UEF metric that results from the new federal test procedures. The Energy Commission intends to utilize the conversion factors the Department of Energy has committed to publishing, while simultaneously developing new calculation methods using UEF for the CBECC-Res compliance software and ACM Reference Manual. Additionally, while there are multiple draw patterns in the new test procedure, the draw patterns that are relevant to predominately used residential water heaters are limited ($\geq$4 gal/min GPM for instantaneous and 51$\leq$FHR$\leq$75 gallons for storage water heater), which greatly reduces the complexity in developing the new water heating calculation method.

Staff also received comments raising the issue of the possibility of higher water usage with instantaneous water heaters. Water usage is highly depended on individual user, and instantaneous water heaters and storage water heaters have fundamentally different operation profiles. Staff is aware of past analysis that indicated a potential for greater consumption of hot water given the "limitless" supply provided by an instantaneous water heater; therefore, to understand the impact of water usage, staff relied on a field study by The National Renewable Energy Laboratory (NREL) that monitored actual hot water usage over a period of time. The study monitored a retrofit program in which storage water heaters in 110 public housing units were replaced with instantaneous water heaters. Their report concluded that on average there is no impact on overall water usage resulting from installing instantaneous water heaters. This report has been added to the Documents Relied Upon for the rulemaking.