APS

Palo Verde Nuclear Generating Station

**David Mauldin**
Vice President
Nuclear Engineering and Support

TEL (623) 393-5553
FAX (623) 393-6077

Mail Station 7605
P.O. Box 52034
Phoenix, AZ 85072-2034

102-04592-SAB/TNW/JAP
July 26, 2001

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-37
Washington, DC 20555-0001

Reference: 1) Letter 102-04552-CDM/SAB/JAP, dated April 1, 2001, "Request for Amendment to Various Administrative Controls for Section 5.0 of Technical Specifications," from C. D. Mauldin, APS, to USNRC

Dear Sirs:

**Subject: Palo Verde Nuclear Generating Station (PVNGS)**
**Units 1, 2, and 3**
**Docket Nos. STN 50-528/529/530**
**Additional Information for the Addition of the CENTS Computer Code to Section 5.0 of Technical Specifications**

In Reference 1, Arizona Public Service Company (APS) requested an amendment to various administrative controls of Technical Specifications (TS) Section 5.0 for PVNGS Units 1, 2, and 3. Included in this amendment request was the addition of the CENTS computer code to the list of analytical methods in TS 5.6.5 used to determine the core operating limits.

On April 25, 2001 and May 29, 2001 the NRC staff and PVNGS conducted phone calls concerning the Reference 1 submittal. Some questions were asked concerning the use of the CENTS computer code, specifically regarding information presented in Enclosure 3 of Reference 1. PVNGS is providing responses to these questions in the accompanying enclosure.

A001

No commitments are being made to the NRC by this letter.

Should you have any questions, please contact Thomas N. Weber at (623) 393-5764.

Sincerely,

CDM/TNW/JAP/kg

Enclosure

| | | |
|---|---|---|
| cc: | E. W. Merschoff | (w/ enclosure) |
| | J. N. Donohew | (w/ enclosure) |
| | J. H. Moorman | (w/ enclosure) |

STATE OF ARIZONA )
) ss.
COUNTY OF MARICOPA )

I, David Mauldin, represent that I am Vice President Nuclear Engineering and Support, Arizona Public Service Company (APS), that the foregoing document has been signed by me on behalf of APS with full authority to do so, and that to the best of my knowledge and belief, the statements made therein are true and correct.

David Mauldin

Sworn To Before Me This 26 Day Of July, 2001.

Nora E. Meador
Notary Public

"OFFICIAL SEAL"
Nora E. Meador
Notary Public-Arizona
Maricopa County
My Commission Expires 4/6/2003

Notary Commission Stamp

# ENCLOSURE 1

Additional Information for the Addition of the CENTS Computer Code to Section 5.0 of Technical Specifications

## 1.0 Background

During the April 25, 2001 and May 29, 2001 phone calls between the PVNGS and NRC staff, some questions were raised regarding differences in the initial conditions between the CESEC and CENTS code Nuclear Steam Supply System (NSSS) response predictions in the benchmark study presented in Enclosure 3 of the Technical Specification submittal.

To address these questions, and to facilitate the NRC staff review process, a supplement to the benchmark study was performed by PVNGS to address noted differences in the initial conditions and their respective impacts. The supplemental study determined that most of the differences (e.g., reactivity, SG mass and pressurizer level) are due to small inconsistencies between the input conditions selected for the CESEC and CENTS cases, or incorrect tuning of the CESEC basedeck (e.g., SG initial pressure). It also concluded that the benchmark study previously submitted to the NRC staff remains valid. The results and conclusions of this supplemental study were reviewed by Westinghouse, and are presented below.

The benchmark study was performed to demonstrate that the predictions of the NSSS response by CESEC and CENTS codes for the CEA ejection event are comparable, and that CENTS can replace CESEC in accident analyses to predict the NSSS response. Although some differences existed between the plant specific basedecks and between the event specific casedecks of each code, the study showed that similar trends are obtained in both codes' predictions. Some of the differences in the initial and transient conditions used in the study and their effects on the transient were explained in Enclosure 3 of Reference 1. One difference, namely the initial steam generator pressure, was not specifically addressed in the submittal and has been added.

## 2.0 Supplemental Study

The supplemental study examined the following input/initial condition differences:

**2.1 Scram Reactivity:** As explained in the Section 1.1.1.5 of Enclosure 3 of Reference 1, there was a difference in the scram reactivity credited to be inserted after scram. The scram worth used in the CESEC case was overly conservative, however, there is no impact on the peak RCS pressure due to this difference since the total rod insertion occurs after the RCS peak pressure is reached. For the supplemental study, the CENTS scram worth was revised to match the CESEC value.

**2.2 Modeling of Feedwater Flow and Enthalpy**: As explained in Section 1.1.1.4 of Enclosure 3 of Reference 1, the ramp down of the feedwater flow following the turbine trip was modeled differently in CENTS and CESEC cases. While CESEC used the basedeck default ramp scheme (flow goes to zero in approximately 20 seconds), the CENTS casedeck assumed a conservative, instantaneous termination of the feedwater flow (flow goes to zero in 1 second). The CENTS casedeck also used a lower feedwater enthalpy than CESEC, which increased the cool down by the secondary system. Again, there is no effect on the peak RCS pressure due to these differences, since the RCS peak pressure occurs prior to the impact of reduced feedwater flow in the secondary system. For comparison purposes, the supplemental study matched the CENTS feedwater flow ramp down to the CESEC default ramp scheme, and used the same enthalpy as in the CESEC case.

**2.3 Initial Pressurizer Volume**: A slightly lower initial pressurizer level was used in the CENTS casedeck vs. the CESEC casedeck due to the format difference in the entry of the input value (CESEC requires volume input while CENTS requires a level height input). This difference was not specifically addressed in Enclosure 3 of Reference 1 since the effect of the difference on the peak RCS pressure due to a slightly earlier trip on high pressurizer pressure is minimal (approximately 2 psi). For comparison purposes in the supplemental study, the CENTS initial water level height in the pressurizer is increased to provide a closer match to the CESEC initial volume.

**2.4 Initial Steam Generator Pressure**: There was about 35 psi difference in initial steam generator pressures between the two codes (Figure 1.1.1-6 of the Enclosure 3 of Reference 1). This difference between the initial pressures was due to inconsistent specification of steam generator design parameters in the CESEC basedeck, and does not reflect an intrinsic difference between the two codes. The CESEC case in the supplemental study was tuned with inputs chosen so that the initial steam generator pressure was in good agreement with measured plant data and the CENTS basedeck (note that in the earlier study the CENTS basedeck was prepared based on the measured plant data while CESEC basedeck reflected predicted design values). With these changes, only a small difference (approximately 8 psi) remains between the initial SG pressures calculated by the two codes. The effect of the initial steam generator pressure on the peak RCS pressure is not significant (determined to be approximately 6 psi due to 35 psi initial pressure difference that was presented in Reference 1) for this event.

## 3.0 Results

The results of the supplemental study to Figures 1.1.1-1 through 1.1.1-9 in Enclosure 3 of Reference 1 are presented in the Figures 1 through 9. The results show that similar trends for NSSS response are obtained by both the codes. The explanation of differences between the CESEC and CENTS code predictions and the differences between the results presented in Reference 1 and this supplemental study are as follows.

**3.1 RCS Pressure after Reactor Trip (Figure 3):** Between the time of maximum RCS pressure (~18 secs.) and 30 seconds, the CENTS predicted pressure drops below the CESEC predicted pressure. This is due to the different SG models in CESEC and CENTS. As explained in Reference 2, the CENTS steam generator model includes a separate downcomer node. This downcomer node explicitly contains subcooled water, and this relatively cold water provides a significant thermal inertia and heat sink after trip. In contrast, CESEC models the steam generator as a single node containing saturated water and steam. Because of this difference, CESEC predicts some RCS swell after trip, which results in higher RCS pressure. Some of the other important parameters in addition to RCS pressure are affected by the different SG models. For example, between 30 and 60 seconds, the RCS temperatures calculated by CENTS are colder than those calculated by CESEC.

To demonstrate the effect of this thermal inertia after the trip, the supplemental case is executed up to 100 seconds (the transient that was presented in Reference 1 ended at 60 seconds). After the termination of the feedwater flow, recirculation in the steam generators equalizes the temperatures in the downcomer and the evaporator/riser for the CENTS simulation resulting in a converging trend in the CENTS and CESEC predictions for RCS pressures and temperatures.

**3.2 Steam Generator Pressure (Figure 6):** After correcting the CESEC initial steam generator pressure and matching the feedwater flow input in both CESEC and CENTS cases, the plot presented in Figure 6 of this supplemental study shows a better comparison of both code's predictions. Two features of the CENTS code contribute to the difference in pressure predictions between the time of trip and the time of opening of MSSVs (~ at 1300 psia) namely, the detailed modeling of the main steam line header, and the effect of thermal inertia provided by the separate downcomer node. The first one provides a small addition to heat removal by the steam generators after the turbine admission valves are closed. CESEC does not model the pressure difference between the steam generators and turbine admission valves, while CENTS calculates additional steam flow out of the steam generators after the turbine admission valves are closed until the pressure in the main steam line header reaches equilibrium. This phenomenon can be seen in the integrated steam flow plot (Figure 9) and is the cause for the slight change in the rate of pressure increase between the time of trip and approximately 20 seconds in CENTS steam generator pressure. The second feature was explained in 3.1 above, and results in the difference in steam generator pressure responses.

The difference in steam generator pressure trend around 90 seconds is caused by closure of the MSSVs in CESEC. While not shown in Figure 9, MSSV closure occurs shortly after 100 seconds in CENTS.

**3.4 Steam Generator Level (Figure 7):** In both Reference 1 and the supplemental study, CESEC and CENTS show different predictions of steam generator level after the trip. This is due to the differences in level representation in the respective codes. CENTS calculates the level dynamically, while in CESEC the level is extracted from a tabular format based on the power level and steam generator mass. In both codes, steam generator heat transfer is calculated based on the steam generator mass rather than the level, thus this difference in the level treatment does not affect the overall system response. This conclusion is clearly supported by the steam generator mass trends shown in Figure 8.

**3.5 Steam Generator Mass (Figure 8):** Figure 1.1.1-8 of Reference 1 showed a difference between the predicted steam generator mass in CESEC and CENTS codes. This was due to the difference in feedwater flow input that is explained in Section 2.2. The supplemental study matches the feedwater flows in both codes, and as a result, the steam generator masses show good agreement.

## 4.0 Conclusion

From the results presented in Reference 1, and the supplemental study presented above, the difference in initial steam generator pressures and other small differences in code input discussed in Section 2.0 do not invalidate the conclusions of Reference 1. The two codes are in general good agreement in predicting the NSSS response to a CEA ejection event. The CENTS provides an acceptable methodology for predicting the NSSS response to CEA ejection events.

## 5.0 Reference


1. Letter 102-04552-CDM/SAB/JAP, dated April 1, 2001, "Request for Amendment to Various Administrative Controls for Section 5.0 of Technical Specifications," from C. D. Mauldin, APS, to USNRC

2. CENPD 282-P-A, Volumes 1, 2 and 3, "Technical Manual for the CENTS Code", February 1991.

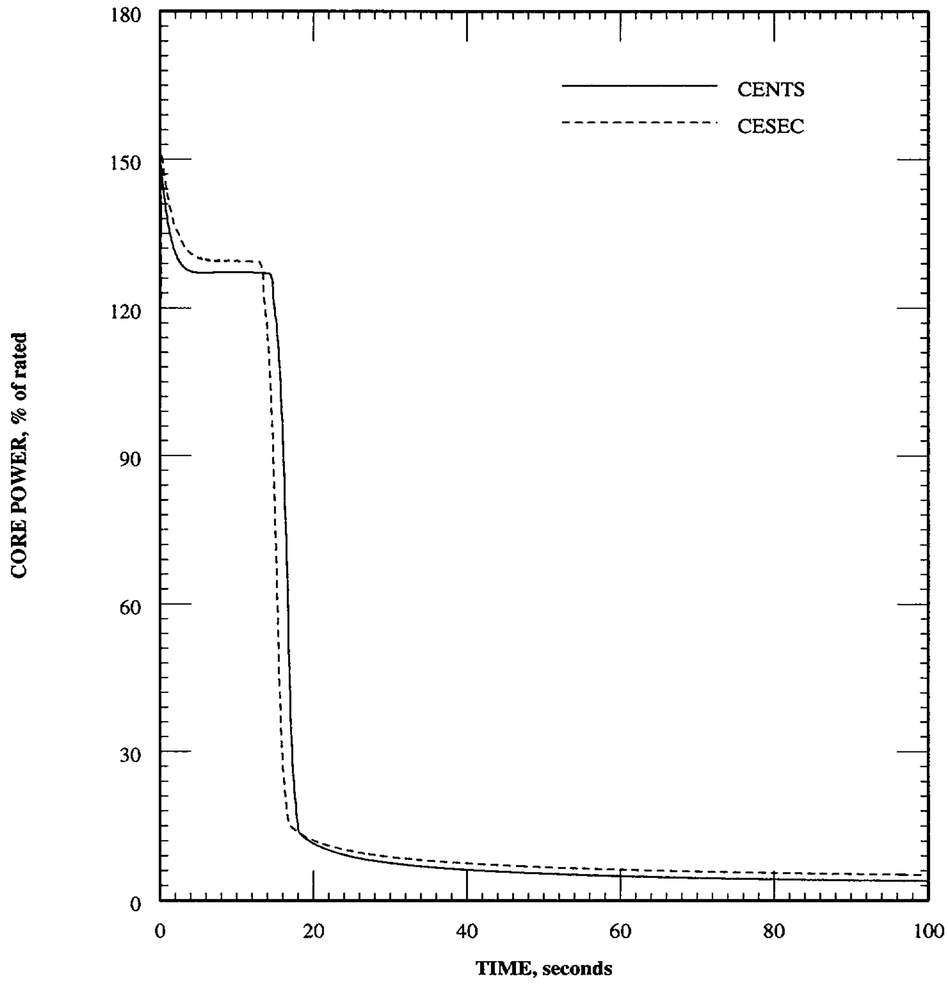


**Figure 1**
**Core Power vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

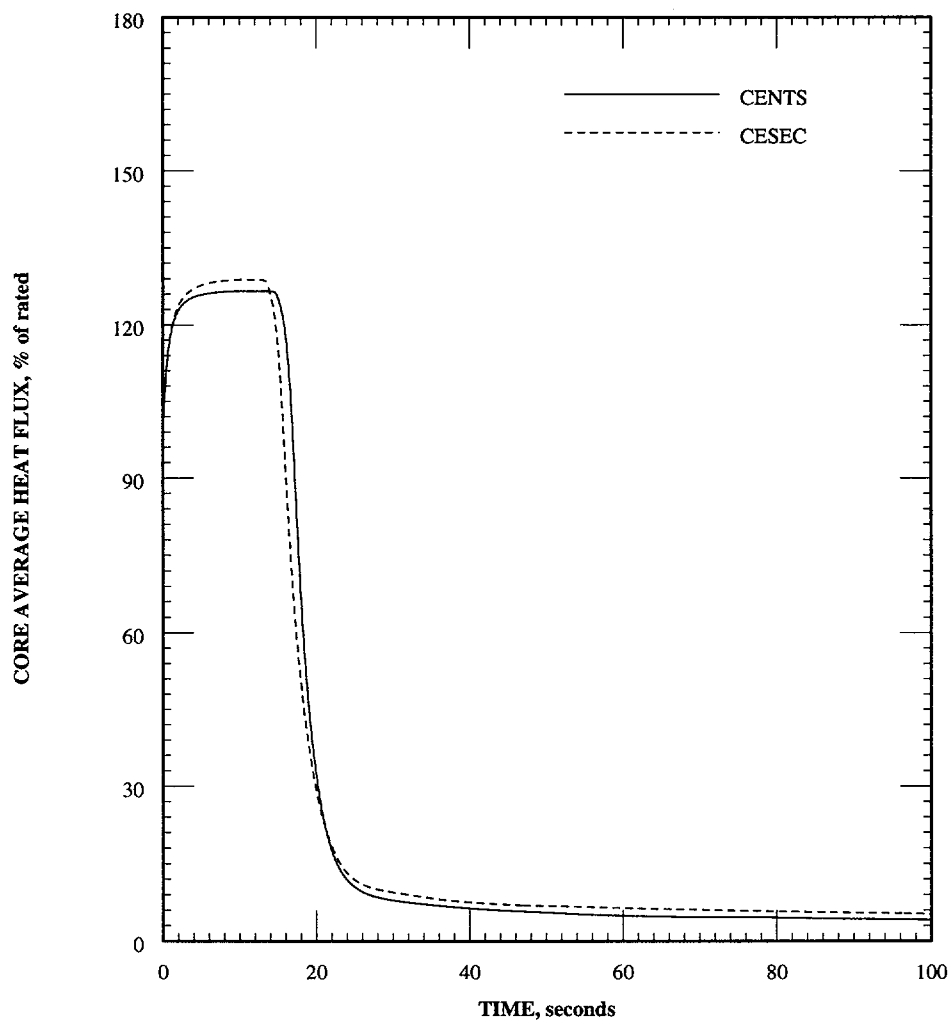


**Figure 2**
**Core Average Heat Flux vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

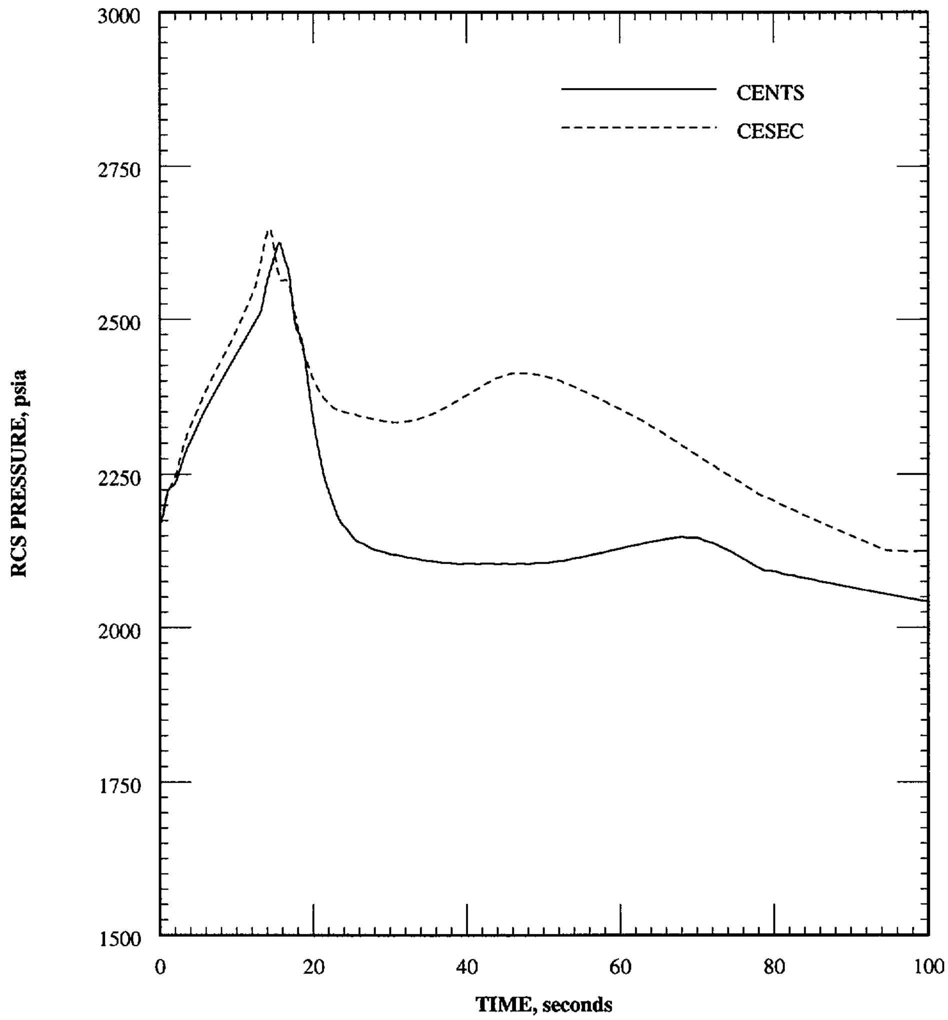


**Figure 3**
**RCS Pressure vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

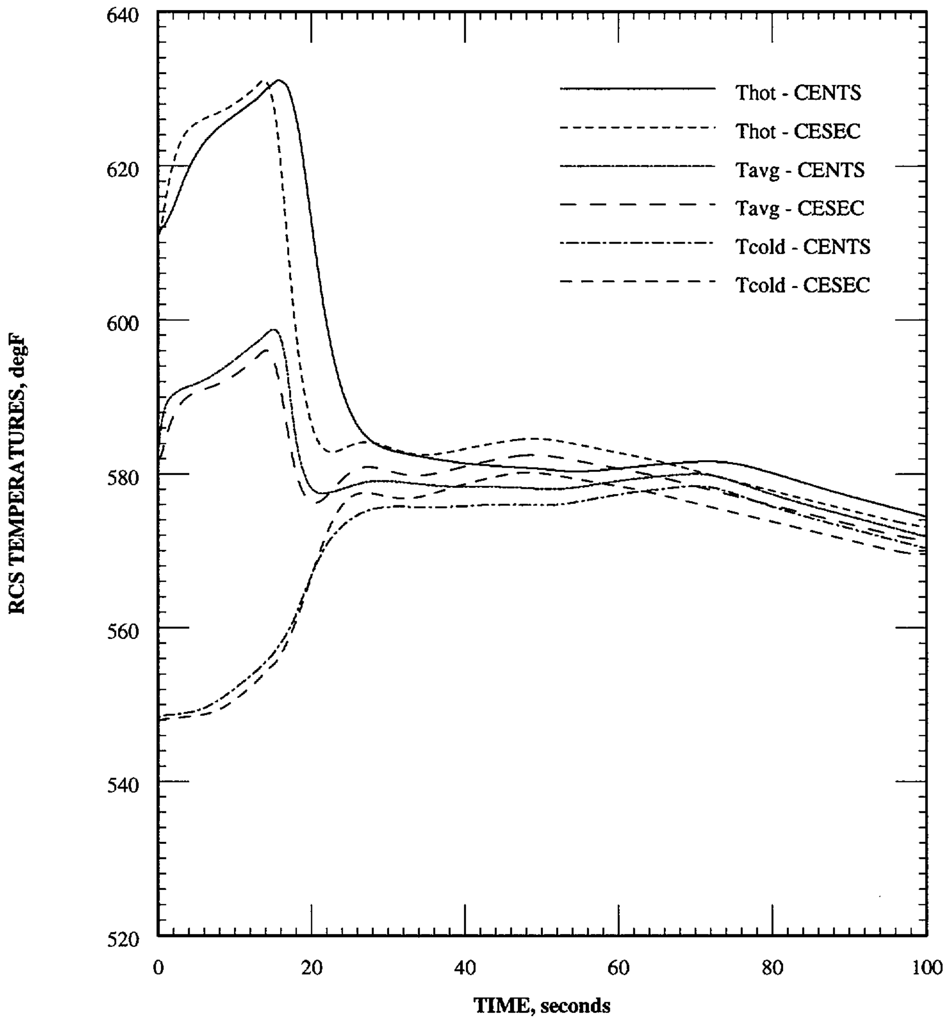


**Figure 4**
**RCS Temperature vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

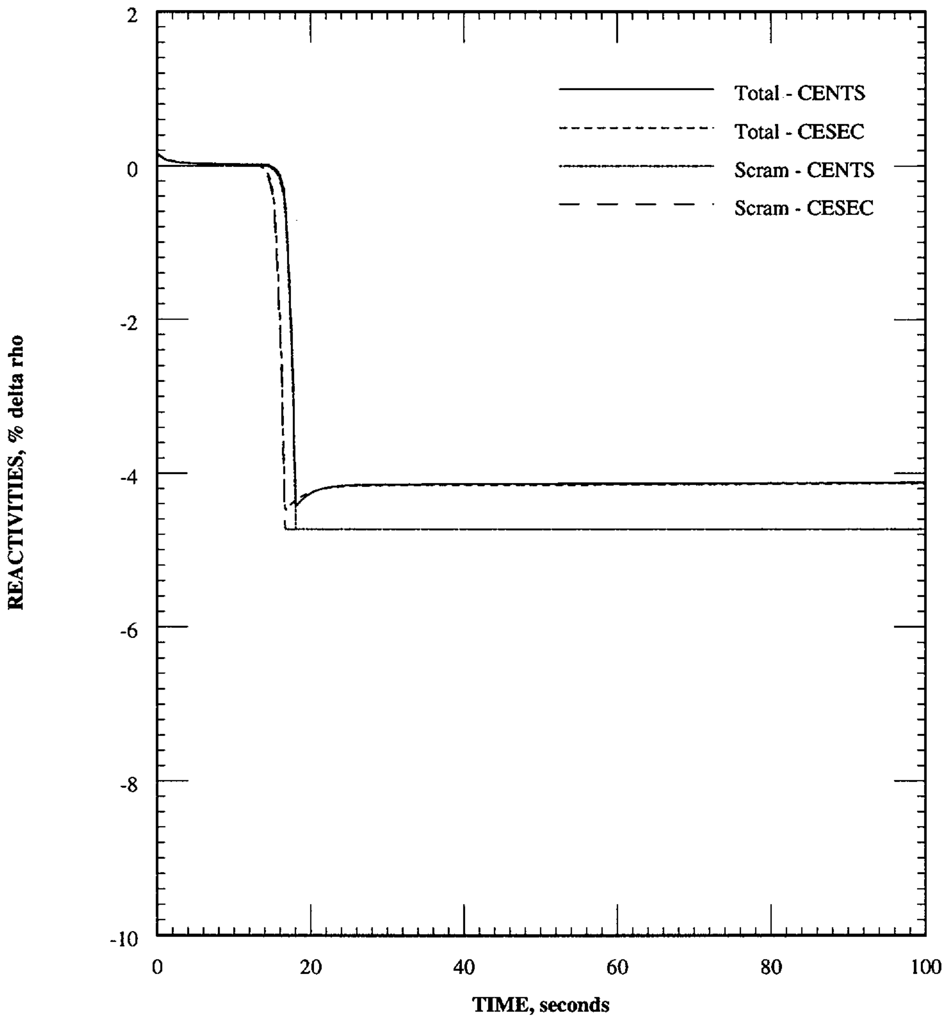


**Figure 5**
**Reactivities vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

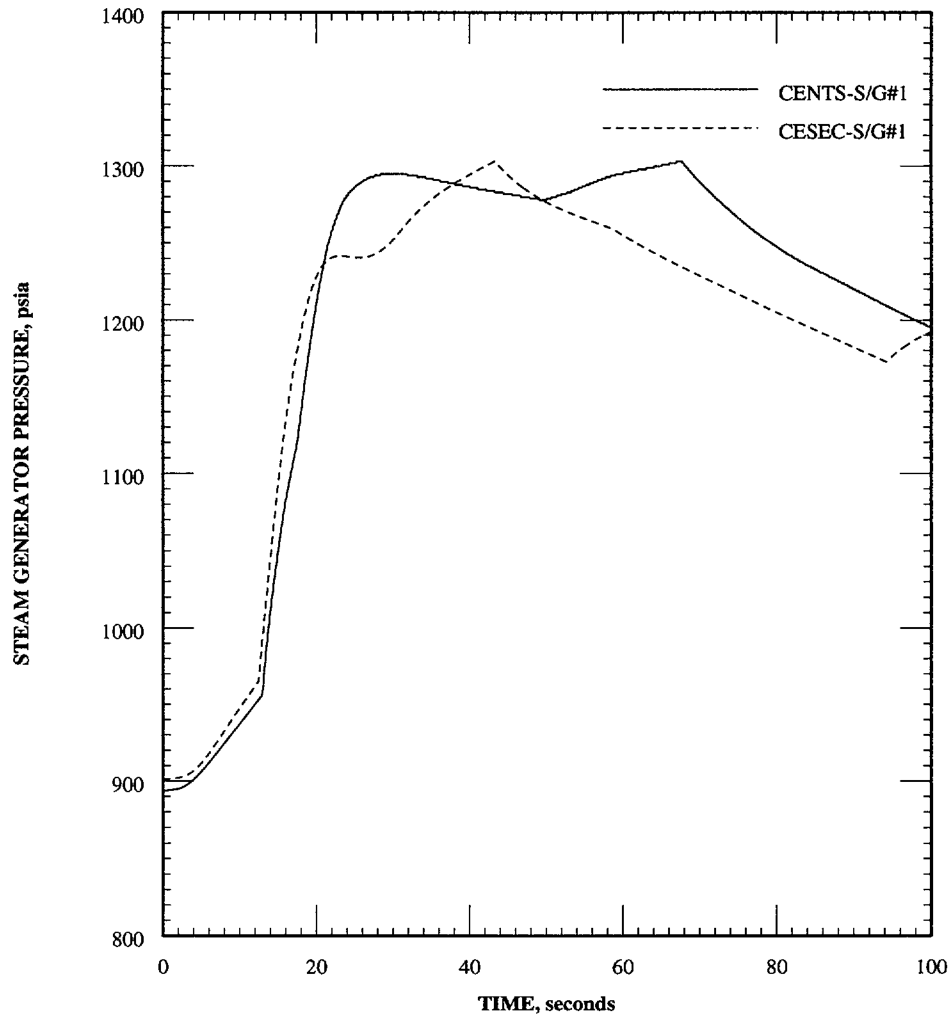


**Figure 6**
**SG Pressure vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

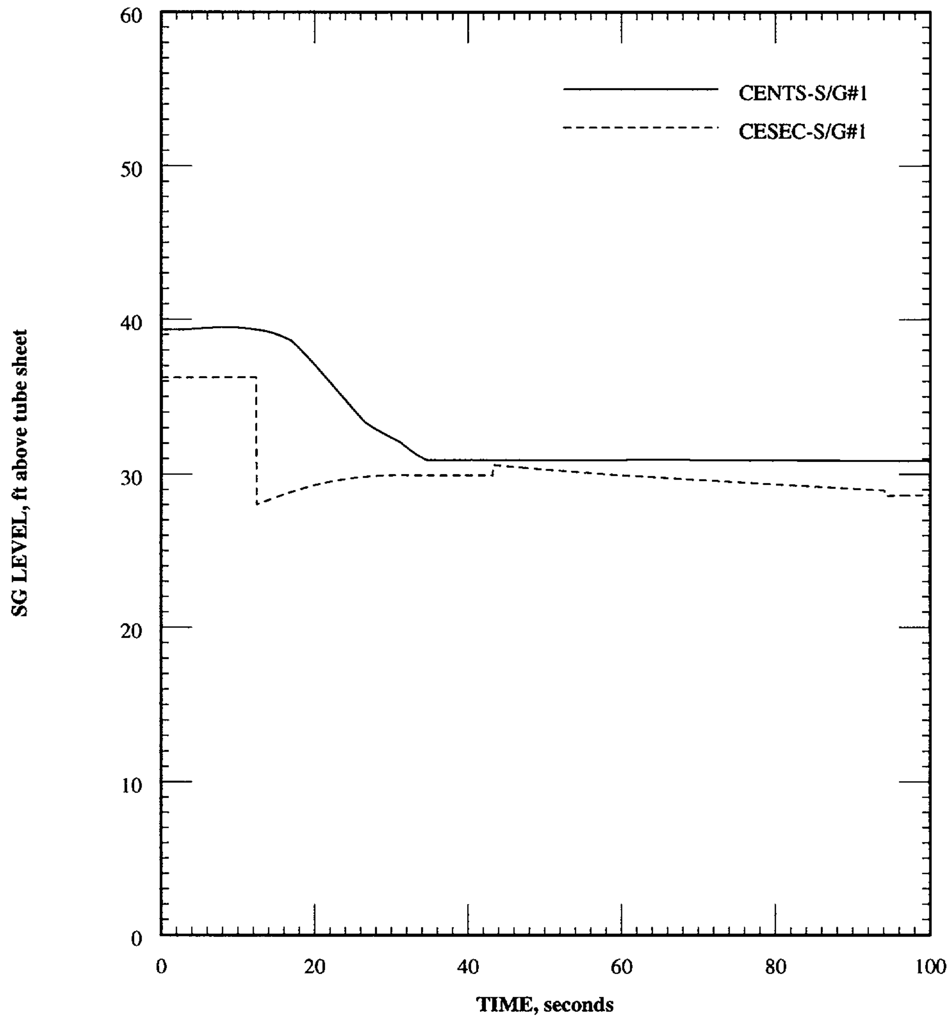


**Figure 7**
**SG Level vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

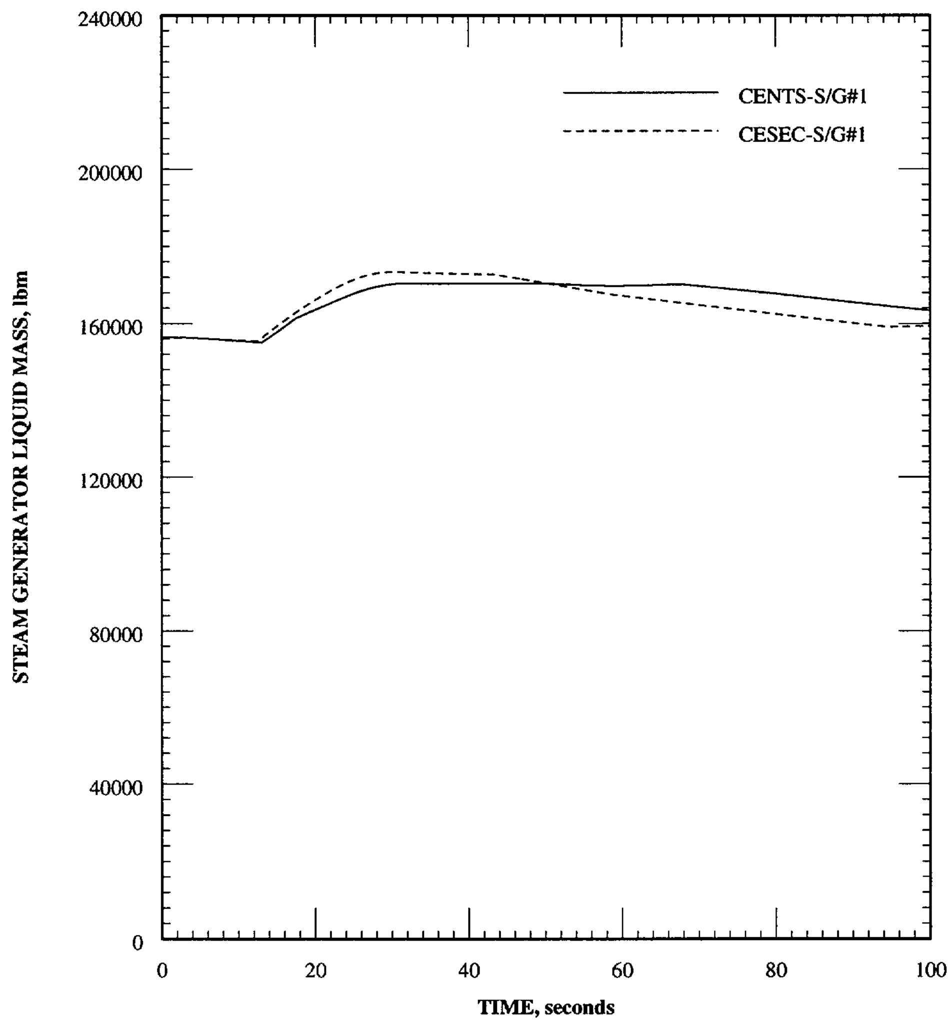


**Figure 8**
**SG Mass vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**

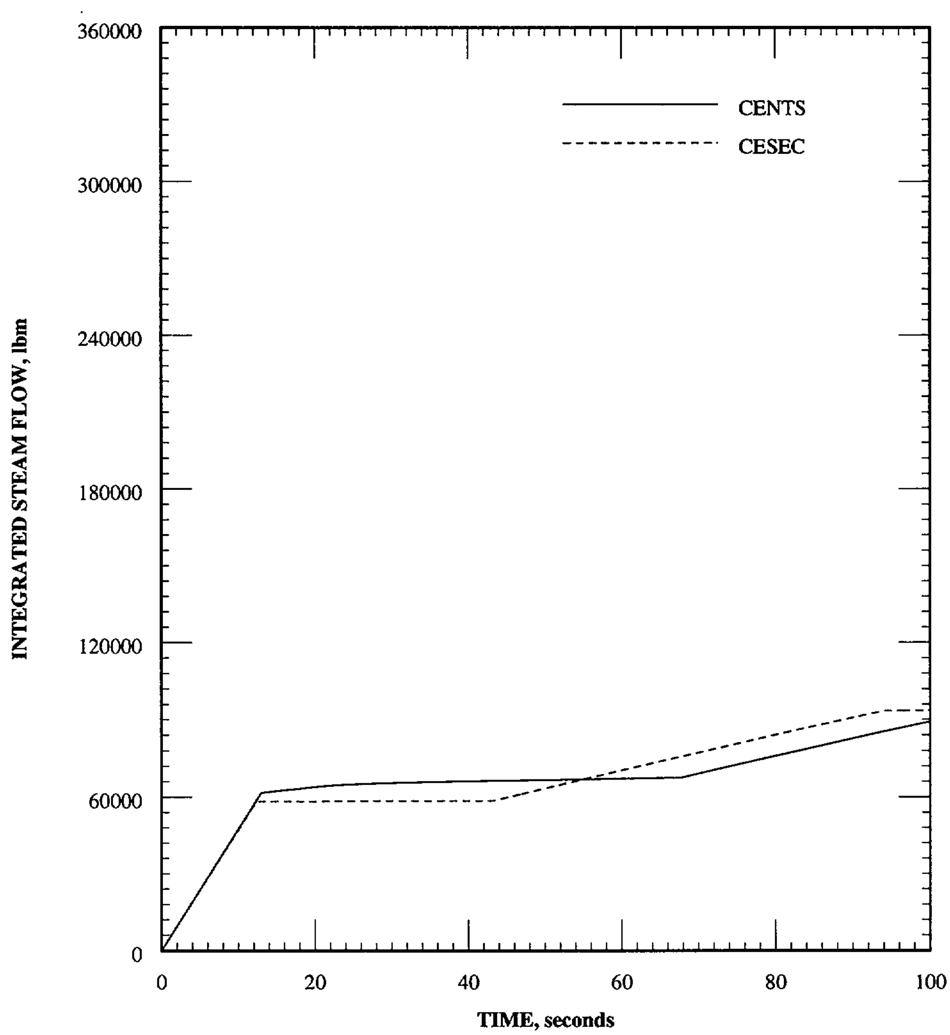


**Figure 9**
**Integrated Steam Flow vs. Time**
**CEA Ejection RCS Peak Pressure Analyses**