15.3 DECREASE IN REACTOR COOLANT SYSTEM FLOW RATE

The results of event analyses for the current cycles are in Appendix 15C for SSES Unit 1 and Appendix 15D for SSES Unit 2. Appendix 15E has information and analytical results that are for non-limiting events for the initial cycles for Units 1 and 2. Note that since the data in Appendix 15E is for the initial cycles for Units 1 and 2, the variable values do not represent the actual values if these events were to occur for the current cycles for Units 1 and 2. However, the data and figures in Appendix 15E do show qualitative behavior of the non-limiting events.

15.3.1 RECIRCULATION PUMP TRIP

This event is non-limiting, and therefore, it is not explicitly analyzed each cycle. The analysis described below was performed for the initial cycles for Units 1 and 2.

15.3.1.1 Identification of Causes and Frequency Classification

15.3.1.1.1 Identification of Causes

Recirculation pump motor operation can be tripped off by design for intended reduction of other transient core and RCPB effects as well as randomly by unpredictable operational failures. Intentional tripping will occur in response to:

(1) Reactor vessel water level L2 set point trip.

(2) TCV fast closure or Stop Valve closure.

(3) Failure to scram high pressure set point trip.

(4) Motor branch circuit over-current protection.

(5) Motor overload protection.

(6) Suction block valve not fully open.

Random tripping will occur in response to:

(1) Operator error.

(2) Loss of electrical power source to the pumps.

(3) Equipment or sensor failures and malfunctions which initiate the above intended trip response.

15.3.1.1.2 Frequency Classification

15.3.1.1.2.1 Trip of One Recirculation Pump

This transient event is categorized as one of moderate frequency.

15.3.1.1.2.2 Trip of Two Recirculation Pumps

This transient event is categorized as one of moderate frequency.

15.3.1.2 Sequence of Events and Systems Operation

15.3.1.2.1 Sequence of Events

15.3.1.2.1.1 Trip of One Recirculation Pump

Table 15E.3.1-1 lists the sequence of events for Figure 15E.3.1-1.

15.3.1.2.1.2 Trip of Two Recirculation Pumps

Table 15E.3.1-2 lists the sequence of events for Figure 15E.3.1-2.

15.3.1.2.1.3 Identification of Operator Actions

15.3.1.2.1.3.1 Trip of One Recirculation Pump

Since no scram occurs for trip of one recirculation pump, no immediate operator action is required, unless the current power/flow condition is in either stability Region I or II of the power/flow maps for Units 1 and 2, (see COLR, FSAR Section 16.3). If the reactor is in either of these regions, the operator must take immediate action to avoid possible instability. Otherwise, as soon as possible, the operator must verify that no operating limits are being exceeded, and reduce flow of the operating pump to conform to the single pump flow criteria. Also, the operator must determine the cause of failure prior to returning the system to normal and follow the restart procedure.

15.3.1.2.1.3.2 Trip of Two Recirculation Pumps

If the reactor scrams with the turbine trip resulting from reactor water level swell, the operator should regain control of reactor water level through RCIC operation, monitoring reactor water level and pressure control after shutdown. When both reactor pressure and level are under control, the operator should secure both HPCI and RCIC as necessary. The operator must also determine the cause of the trip prior to returning the system to normal and perform those actions illustrated in Table 15E.1.1-1.

15.3.1.2.2 Systems Operation

15.3.1.2.2.1 Trip of One Recirculation Pump

Tripping a single recirculation pump requires no protection system or safeguard system operation. This analysis assumes normal functioning of plant instrumentation and controls.

15.3.1.2.2.2 Trip of Two Recirculation Pumps

Analysis of this event assumes normal functioning of plant instrumentation and controls, and plant protection and reactor protection systems.

Specifically, this transient takes credit for vessel level (L8) instrumentation to trip the turbine. Reactor shutdown relies on scram trips from the turbine stop valves. High system pressure is limited by the pressure relief valve system operation.

15.3.1.2.3 The Effect of Single Failures and Operator Errors

15.3.1.2.3.1 Trip of One Recirculation Pump

Since no corrective action is required, other than that described in Subsection 15.3.1.2.1.3.1, no additional effects of single failures need be discussed. If additional SAEF or SOE are assumed (for envelope purposes the other pump is assumed tripped) then the following two pump trip analysis is provided.

15.3.1.2.3.2 Trip of Two Recirculation Pumps

Table 15E.3.1-2 lists the vessel level (L8) trip event as the first response to initiate corrective action in this transient. The level (L8) is intended to prohibit moisture carryover to the main turbine. Multiple level sensors are used to sense and detect when the water level reaches the L8 set point. At this point, a single failure will neither initiate nor impede a turbine trip signal. Turbine trip signal transmission circuitry, however, is not built to single failure criterion. The result of a failure at this point would have the effect of delaying the pressurization "signature." However, high moisture levels entering the turbine can cause vibration and trip the turbine via turbine supervisory instrumentation.

Scram trip signals from the turbine are designed such that a single failure will neither initiate nor impede a reactor scram trip initiation.

15.3.1.3 Core and System Performance

15.3.1.3.1 Mathematical Model

The nonlinear, dynamic model described in Reference 15.3-4 was used to simulate this event for the initial cycles of Unit 1 and Unit 2.

15.3.1.3.2 Input Parameters and Initial Conditions

These analyses have been performed, unless otherwise noted, with plant conditions (prior to power uprate) tabulated in Table 15E.0-2.

Pump motors and pump rotors are simulated with minimum specified rotating inertias.

15.3.1.3.3 Results

15.3.1.3.3.1 Trip of One Recirculation Pump

Figure 15E.3.1-1 shows the results of losing one recirculation pump. The tripped loop diffuser flow reverses in approximately 5.7 seconds. However, the ratio of diffuser mass flow to pump mass flow in the active jet pumps increases considerably and produces approximately 143% of normal diffuser flow and 72% of rated core flow. MCPR remains approximately at the Operating Limit, thus the fuel thermal limits are not violated. During this transient, level swell is not sufficient to cause turbine trip and scram.

15.3.1.3.3.2 Trip of Two Recirculation Pumps

Figure 15E.3.1-2 shows graphically this transient with minimum specified rotating inertia. MCPR remains unchanged at the Operating Limit. No scram is initiated directly by pump trip. The vessel water level swell due to rapid flow coastdown is expected to reach the high level trip thereby shutting down the main turbine and feed pump turbines, and indirectly initiating scrams as a result of the main turbine trip. Subsequent events, such as initiation of RCIC and HPCI systems occurring late in this event, have no significant effect on the results.

15.3.1.3.4 Consideration of Uncertainties

Initial conditions chosen for these analyses are conservative and tend to force analytical results to be more severe than expected under actual plant conditions. Actual pump and pump-motor drive line rotating inertias are expected to be somewhat greater than the minimum design values assumed in this simulation. Actual plant deviations regarding inertia are expected to lessen the severity as analyzed. Minimum design inertias were used as well as the least negative void coefficient since the primary interest is in the flow reduction.

15.3.1.4 Barrier Performance

15.3.1.4.1 Trip of One Recirculation Pump

Figure 15E.3.1-1 results indicate a basic reduction in system pressures from the initial conditions. Therefore, the RCPB barrier is not threatened.

15.3.1.4.2 Trip of Two Recirculation Pumps

The high water level trip (L8) trips the turbine which causes the system pressure to increase.

The results shown in Figure 15E.3.1-2 indicate peak pressures stay well below the 1375 psig limit allowed by the applicable code. Therefore, the barrier pressure boundary is not threatened.

15.3.1.5 Radiological Consequences

There are no radiological consequences for a trip of one recirculation pump.
While the consequence of the trip of two recirculation pumps does not result in fuel failure, it does result in the discharge of normal coolant activity to the suppression pool via SRV operation. Since this activity is contained in the primary containment, there will be no exposures to operating personnel. Since this event does not result in an uncontrolled release to the environment, the plant operator can choose to leave the activity bottled up in the containment or discharge it to the environment under controlled release conditions. If purging of the containment is chosen, the release will have to be in accordance with the Technical Requirements Manual; therefore this event, at the worst, would only result in a small increase in the yearly integrated exposure level.

15.3.2 RECIRCULATION FLOW CONTROL FAILURE-DECREASING FLOW

This event is non-limiting, and therefore, it is not explicitly analyzed each cycle. The analysis described below was performed for the initial cycles for Units 1 and 2.

15.3.2.1 Identification of Causes and Frequency Classification

15.3.2.1.1 Identification of Causes

Three causes of a control failure are:

(1) Failure of an individual loop of recirculation motor generator set speed control logic (ICS) or positioning control of an individual scoop tube actuator can result in a rapid flow decrease in only one recirculation loop.

(2) A Failure of the common ICS logic inputting to the #1 and #2 Runback Limiters can generate a minimum speed demand signal to both recirculation flow control loops.

(3) A failure of the common ICS logic inputting to the Rundown logic can generate a decreasing speed demand bias signal maximum 15% to both recirculation flow control loops.

15.3.2.1.2 Frequency Classification

This transient disturbance is categorized as an incident of moderate frequency.

15.3.2.2 Sequence of Events and Systems Operation

15.3.2.2.1 Sequence of Events

15.3.2.2.1.1 Failure of One Speed Control Loop Including Failure of the Redundant Control Processor (CP) Pair

The sequence of events for this transient is similar to, and can not be more severe than that listed in Table 15E.3.1-1 for the trip of one recirculation pump.

15.3.2.2.1.2 Identification of Operator Actions

As soon as possible, the operator must verify that no operating limits are being exceeded. In particular, the operator must determine if the current power/flow condition is in operational regions I or II of the power/flow maps for Units 1 and 2, (Figures 15C.0-1 and 15D.0-1). If the reactor is in either of these regions, the operator must take immediate action to avoid possible instability. If any other operating limits are being exceeded, corrective actions must be initiated. Also, the operator must determine the cause of the trip prior to returning the system to normal.

15.3.2.2.2 Systems Operation

Normal plant instrumentation and control is assumed to function. Credit is taken for scram in response to vessel high water level (L8) trip if it occurs. This is true for single and both pump speed controller failure events.

15.3.2.2.3 The Effect of Single Failures and Operator Errors

The single failure and operator error considerations for these events are the same as discussed in the section on recirculation pump trips, Subsection 15.3.1.2.3. Failure of two MG-sets and thus a double RPT or the common failure of digital recirculation pump speed controllers and thus a two RPT situation would be the envelope cases for additional SEF or SOE.

15.3.2.3 Core and System Performance

15.3.2.3.1 Mathematical Model

Since this event is less severe than the recirculation pump trips discussed in Subsection 15.3.1, this event was analyzed qualitatively.

15.3.2.3.2 Input Parameters and Initial Conditions

See Subsection 15.3.2.3.1.

15.3.2.3.3 Results

15.3.2.3.3-1

The ICS design for recirculation pump speed control incorporates a Signal Failure/Control System Fault feature to avoid the potential for uncontrolled reactivity excursions due to failed ICS hardware, interruption of control signal propagation, and self detected diagnostic faults. If detected, these faults result in a Scoop Tube Lock. Separation between recirculation loops ‘A’ and ‘B’ has been maintained within the ICS structure. Additional layers of redundancy and separation of functions exists within ICS such that single-failure criteria are maintained in most aspects. In the unlikely occurrence of a common failure resulting in complete loss of the control processing pairs within the Integrated Control System for both recirculation pump speed control, a zero demand signal will be established and both reactor recirculation pumps will go to minimum speed. This transient can never be more severe than the simultaneous trip of both recirculation pumps, evaluated in Subsection 15.3.1.3.3.2

15.3.2.3.3-2

In case of failure of one speed control loop, the scoop tube positioners are designed so that the flow change rate limit is determined by the individual stroking rate. The MG Set speed reduction is limited to less than approx. 25% per second due to the inherent design characteristic, mostly as a result of the systems mechanical inertia (e.g. scoop tube posititioner response and physical inertia of the MG set). This case is similar to the trip of one recirculation pump, described in Subsection 15.3.1.3.3.1, and is less severe than the transient that results from the simultaneous trip of both recirculation pumps.

15.3.2.3.4 Consideration of Uncertainties

Initial conditions chosen for these analyses are conservative and tend to force analytical results to be more severe than otherwise expected. These analyses, unlike the pump trip series, will be unaffected by deviations in pump, pump motor and driveline inertias since it is the flow controllers that cause rapid recirculation decreases.

15.3.2.4 Barrier Performance

The barrier performance considerations for these events are the same as discussed in the section on recirculation pump trips.

15.3.2.5 Radiological Consequences

While the consequence of this event does not result in fuel failure, it does result in the discharge of normal coolant activity to the suppression pool via SRV operation. Since this activity is contained in the primary containment, there will be no exposures to operating personnel. Since this event does not result in an uncontrolled release to the environment, the plant operator can choose to leave the activity bottled up in the containment or discharge it to the environment under controlled release conditions. If purging of the containment is chosen, the release will have to be in accordance with the Technical Requirements Manual; therefore this event, at the worst, would only result in a small increase in the yearly integrated exposure level.

15.3.3 RECIRCULATION PUMP SEIZURE

15.3.3.1 Identification of Causes and Frequency Classification

The seizure of a recirculation pump is considered as a design basis accident event. The analysis has been conducted with consideration of one and two loop operation.

In order to ensure compliance with the acceptance criteria for a design basis accident, a more conservative criterion, MCPR, is used to analyze this event. This approach assigns an initial MCPR for the event such that MCPR is always above the SLMCPR. By maintaining MCPR above the SLMCPR localized dryout within the fuel assembly is avoided, and fuel damage will not occur. If fuel damage does not occur, then the acceptance criteria regarding dose for a design basis accident are met.

Refer to Section 5.1 for specific mechanical considerations and Chapter 7 for electrical aspects.

The seizure event postulated would not be the mode failure of such a device. Safe shutdown components (e.g., electrical breakers, protective circuits) would preclude an instantaneous seizure event.

15.3.3.1.1 Identification of Causes

The case of recirculation pump seizure represents the extremely unlikely event of nearly instantaneous stoppage of the pump motor shaft of one recirculation pump. This event produces a very rapid decrease of core flow as a result of the large hydraulic resistance introduced by the stopped rotor.

15.3.3.1.2 Frequency Classification

This event is considered to be a limiting fault.

15.3.3.2 Sequence of Events and Systems Operations

15.3.3.2.1 Sequence of Events

For a pump seizure from two loop operation, the typical sequence of events for Unit 1 is given in Table 15C.3.3-1 and in Table 15D.3.3-1 for Unit 2. Figures 15C.3.3-1 and 15D.3.3-5 show the typical response of key variables following a pump seizure from two loop operation for Units 1 and 2, respectively. For single loop operation, the typical sequence of events for Unit 1 are given in

Table 15C.3.3-2 and in Table 15D.3.3-2 for Unit 2. Figures 15C.3.3-3 and 15D.3.3-6 show the typical response of key variables following a pump seizure from single loop operation for Units 1 and 2, respectively.

15.3.3.2.1.1 Identification of Operator Actions

If the reactor were to scram, the operator would perform the actions listed in Table 15E.1.1-1. If necessary, the operator would regain control of reactor water level through HPCI and/or RCIC operation or by restart of a feedwater pump; and must monitor reactor water level and pressure control after shutdown.

15.3.3.2.2 Systems Operation

To properly simulate the expected sequence of events, the analysis of this event assumes normal functioning of plant instrumentation and controls, and plant protection systems. The seizure of a recirculation pump results in a reactor water level swell. If the swell is of sufficient magnitude, the high vessel water level (L8) trip would be reached initiating a turbine trip and reactor scram. The analysis of the pump seizure assumes that neither a reactor scram occurs nor that the water level gets high enough to initiate a L8 trip.

Operation of safe shutdown features, though not included in this simulation, is expected to be utilized to maintain adequate water level.

15.3.3.2.3 The Effect of Single Failures and Operator Errors

Single failures in the scram logic originating via the high vessel level (L8) trip are similar to the considerations in Subsection 15.3.1.2.3.2. A trip due to high water level (L8) for this event is not expected (see key parameter response figures).

15.3.3.3 Core and System Performance

15.3.3.3.1 Mathematical Model

The pump seizure accidents from single loop and two loop operation were analyzed using the methods and model described in References 15.3-1, 15.3-2, and 15.3-5 for ATRIUM-10 and Reference 15.3-3 for ATRIUM-11.

15.3.3.3.2 Input Parameters and Initial Conditions

For the purpose of evaluating consequences to the fuel thermal limits, this transient event is assumed to occur as a consequence of an unspecified, instantaneous stoppage of one recirculation pump shaft.

The analysis for pump seizure from single loop operation was performed for an initial power level of approximately 2652 MWt and 52 Mlbs/hr core coolant flow. For the analysis with two loop operation, the initial conditions for Units 1 and 2 are given in Figures 15C.3.3-1 and 15D.3.3-1.

Also, the reactor is assumed to be operating at thermally limited conditions for each of the initial conditions analyzed. Note that the pump seizure occurs at 0.5 seconds as shown in Figures 15C.3.3-1 through 15C3.3-4 and 15D.3.3-1 through 15D.3.3.-4.

15.3.3.3.3 Results

Typical results of the analysis of the pump seizure accident are shown in Figures 15C.3.3-1 through 15C.3.3-4 and 15D.3.3-5 and 15D.3.3-6 for Units 1 and 2, respectively. The core coolant flow drops rapidly. The water level shows a small increase but falls back to its initial value. The power and heat flux all fall below their initial values as does the reactor dome pressure.

The assumed initial MCPR is set at a value to assure that the limiting MCPR reached during the transient does not fall below the SLMCPR for the pump seizure accident for either two loop or single loop operation.

To account for uncertainties in the ATRIUM-10 model, the delta CPR determined from these analyses, shown in Figures 15C.3.3-2 and 15C.3.3-4, were adjusted by approximately 14% for model uncertainties and 10% based on experience with pressurization events. An additional 0.05 was added to the resulting delta CPR to ensure that the limits being established will bound future 24 month cycles of ATRIUM-10 fuel. ATRIUM-11 model uncertainties are accounted for in the Reference 15.3-3 methodology. The assumed initial MCPR limits are shown in Table 15C.0-4 and 15D.0-4 for SLMCPRs for Units 1 and 2.

15.3.3.3.4 Considerations of Uncertainties

Considerations of uncertainties are included in the methods of analysis described in References 15.3-1, 15.3-2, 15.3-3, and 15.3-5.

15.3.3.4 Barrier Performance

The maximum pressures reached in the reactor coolant system for this accident are given in Tables 15C.0-1 and 15D.0-1. These pressures are within the range allowed by the ASME vessel code. Therefore, the reactor coolant pressure boundary is not threatened by overpressure.

15.3.3.5 Radiological Consequences

Fuel damage is not expected for the pump seizure accident for either two loop or single loop operation. The SRVs are not expected to open during the accident; therefore, no reactor coolant will be released from the reactor to the primary containment.

While the consequences of the pump seizure accident does not result in fuel failure, it may result in the discharge of normal coolant activity to the suppression pool if SRVs are used to control reactor pressure following the accident. Since this activity is contained in the primary containment, there will be no exposures to operating personnel. Since this event does not result in an uncontrolled release to the environment, the plant operator can choose to leave the activity bottled up in the containment or discharge it to the environment under controlled release conditions. If purging of the containment is chosen, the release will have to be in accordance with the Technical Requirements Manual; therefore this event, at the worst, would only result in a small increase in the yearly integrated exposure level.

15.3.4 RECIRCULATION PUMP SHAFT BREAK

15.3.4.1 Identification of Causes and Frequency Classification

The breaking of the shaft of a recirculation pump is considered a design basis accident event. It has been evaluated as a very mild accident in relation to other design basis accidents such as the LOCA. The analysis has been conducted with consideration to a single or two loop operation.

Refer to Chapter 5 for specific mechanical considerations and Chapter 7 for electrical aspects.

The shaft shearing event postulated certainly would not be the mode failure of such a device. Safe shutdown components (e.g., electrical breakers protective circuits) would preclude an instantaneous seizure event.

This postulated event is bounded by the more limiting case of recirculation pump seizure. Quantitative results for this more limiting case are presented in Subsection 15.3.3.

15.3.4.1.1 Identification of Causes

The case of recirculation pump shaft breakage represents the extremely unlikely event of instantaneous stoppage of the pump motor operation of one recirculation pump. This event produces a very rapid decrease of core flow as a result of the large hydraulic resistance introduced by the shaft-rotor condition.

15.3.4.1.2 Frequency Classification

This event is considered to be a limiting fault.

15.3.4.2 Sequence of Events and Systems Operations

15.3.4.2.1 Sequence of Events

A postulated instantaneous break of the pump motor shaft of one recirculation pump as discussed in Subsection 15.3.4.1.1 will cause the core flow to decrease rapidly resulting in water level swell in the reactor vessel. If the vessel water level reaches the high water level setpoint (Level 8), main turbine trip and feedwater pump trip will be initiated. Subsequently, reactor scram and the remaining recirculation pump trip will be initiated due to the turbine trip. Eventually, the vessel water level will be controlled by HPCI and RCIC flow.

15.3.4.2.1.1 Identification of Operator Actions

If the reactor were to scram, the operator would perform actions listed in Table 15E.1.1-1. If necessary, the operator would regain control of reactor water level through HPCI and/or RCIC operation or by restart of a feedwater pump; and he must monitor reactor water level and pressure control after shutdown.

15.3.4.2.2 Systems Operation

Normal operation of plant instrumentation and control is assumed. This event takes credit for vessel water level (Level 8) instrumentation to scram the reactor and trip the main turbine and feedwater pumps. High system pressure is limited by the pressure relief system operation.

Operation of HPCI and RCIC systems is expected in order to maintain adequate water level control.

15.3.4.2.3 The Effect of Single Failures and Operator Errors

Effects of single failures in the high vessel level (L8) trip are similar to the considerations in Subsection 15.3.1.2.3.2.

Assumption of SEF or SOE in other equipment has been examined and this has led to the conclusion that no other credible failure exists for this event. Therefore the bounding case has been considered.

15.3.4.3 Core and System Performance

The severity of the pump seizure event is described in Subsection 15.3.3 and the pump seizure is more severe than the breakage of the recirculation pump shaft. This can be easily demonstrated by consideration of those two events as discussed in subsection below. Since this event is less limiting than the event described in Subsection 15.3.3, only qualitative evaluation is provided. Therefore no discussion of mathematical model, input parameters, and consideration of uncertainties, etc., is necessary.

15.3.4.3.1 Qualitative Results

If this extremely unlikely event occurs, core coolant flow will drop rapidly. The level swell produces a trip of the main and feedwater turbines. Subsequently, A scram is initiated due to turbine trip. Since heat flux decreases much more rapidly than the rate at which heat is removed by the coolant, the threat to thermal limits is no more severe than described in Subsection 15.3.3. Additionally, the bypass valves and momentary opening of some of the safety/relief valves limit the pressure well within the range allowed by the ASME vessel code. Therefore, the reactor coolant pressure boundary is not threatened by overpressure.

The severity of this pump shaft break event is bounded by the pump seizure event (see Subsection 15.3.3). This can be demonstrated easily by consideration of these two events. In either of these two events, the recirculation drive flow of the affected loop decreases rapidly. In the case of the pump seizure event, the loop flow decreases faster than the normal flow coastdown as a result of the large hydraulic resistance introduced by the stopped rotor. For the pump shaft break event, the hydraulic resistance caused by the broken pump shaft is less than that of the stopped rotor for the pump seizure event. Therefore, the core flow decrease following a pump shaft break effect is slower than the pump seizure event. Thus, it can be concluded that the potential effects of the hypothetical pump shaft break accident are bounded by the effects of the pump seizure event.

15.3.4.4 Barrier Performance

The bypass valves and momentary opening of some of the safety/relief valves limit the pressure well within the range allowed by the ASME vessel code. Therefore, the reactor coolant pressure boundary is not threatened by overpressure.

15.3.4.5 Radiological Consequences

Since this accident is no more severe than the pump seizure accident the radiological consequences will be no more severe than those described in Subsection 15.3.3.5.

15.3.5 REFERENCES

15.3-1 NEDE-24011-P-A-14, June 2000, and U.S. Supplement, NEDE-24011-P-A-15, September 2005 and Amendment 26 “General Electric Standard Application for Reactor Fuel”.

15.3-2 NEDC-24154P-A, Revision 1, February 2000, Qualification of the 1-Dimensional Core Transient Model (ODYN) for BWRs” (Supplement 1-Volume 4).

15.3-3 ANP-10300P-A Revision 1, AURORA-B: An Evaluation Model for Boiling Water Reactors; Application to Transient and Accident Scenarios, Framatome, January 2018.

15.3-4 Linford, R.B., ”Analytical Methods of Plant Transient Evaluations for General Electric Boiling Water Reactor”, April 1973 (NEDO 10802).

15.3-5 NEDC-32084P-A, Revision 2, July 2002 “TASC-03A – Computer Program for Transient Analysis of a Single Channel”.