ATTACHMENT 1

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MODIFICATION OF ECCS PUMP START LOGIC

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1. INTRODUCTION

A number of modifications to the Automatic Depressurization System (ADS) were evaluated in an earlier BWR Owners' Group (BWROG) study.* The proposed modifications extend the ADS operation to transient events which do not result in a release of steam to the drywell but which may require depressurization of the reactor pressure vessel (RPV) to maintain adequate core cooling. These modifications or improvements were developed to reduce the dependence on operator action and to satisfy the intent of the Nuclear Regulatory Commission (NRC) requirements, Item II.K.3.18 of NUREG-0737. The NRC subsequently approved two of these modifications known as Options 2 and 4 of the referenced report.* The Option 2 modification eliminates the high drywell pressure permissive from the current logic sequence and adds a manual switch which allows the operator to prevent (inhibit) automatic ADS initiation (Figure 1). The Option 4 modification adds a timer which bypasses the high drywell pressure permissive of the current logic and adds a manual switch which allows the operator to prevent (inhibit) automatic ADS initiation (Figure 2).

Implementation of either option requires that the pump start logic of the low pressure Emergency Core Cooling System (ECCS) for those BWRs listed in Table 1 be modified. This is because the ECCS pump start logic for all BWR 3s and Vermont Yankee requires either (1) high drywell pressure <u>or</u> (2) reactor low-low water level <u>and</u> low RPV pressure (Figure 3). Neither low RPV pressure nor high drywell pressure would be expected on a timely basis for transient events that the ADS modification is intended to cover. Thus, the timely start of the low pressure ECCS pump could not be assured without operator action.

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* "BWR Owners' Group Evaluation of NUREG-0737 Item II.K.3.18 Modification of Automatic Depressurization System Logic", General Electric Company, NEDE-30045, February 1983.

Furthermore, since automatic initiation of ADS requires confirmation that low pressure ECCS pumps are running, timely ADS could not be assured without operator action. Therefore, in order to reduce the dependence on the operator some change to the low pressure ECCS pump start logic is also required for the listed plants.

This report documents the evaluation of two possible modifications to the low pressure ECCS pump start logic which can be implemented with either option of the ADS modification. The evaluated ECCS pump start logic modifications are:

(A) Elimination of the low RPV pressure permissive (Figure 4);

(B) Addition of a bypass timer to the low RPV pressure permissive (Figure 5).

This evaluation is to determine the compatibility of the modified ECCS pump start logic with the modified ADS logic and to identify the advantages and disadvantages of each modification.

2. ECCS PUMP START MODIFICATIONS

2.1 ELIMINATION OF LOW RPV PRESSURE (MOD A)

Modification A (MOD A) of the ECCS pump start logic is to eliminate the low RPV pressure permissive (Figure 4). Although this pump start logic would be identical to that for the BWR 4s, the logic may result in unnecessary pump starts during transient events for the listed plants. This is because the BWRs listed in Table 1 have a common water level initiation for the high pressure ECC systems and the low pressure ECC systems. The low RPV pressure permissive for the Table 1 plants is to prevent unnecessary starts of the low pressure ECCS pump during transient events (e.g. cases where high pressure ECC system can provide adequate core cooling). However, based on the statistics for transient events in BWRs, eliminating the low RPV pressure permissive would, at most, result in two (2) additional pump starts per year. This number of additional pump starts would have insignificant impact on pump wear or pump availability.

2.2 ADDITION OF A BYPASS TIMER TO THE LOW RPV PRESSURE (MOD B)

Modification B (MOD B) of the ECCS pump start logic is to add a bypass timer to the low RPV pressure permissive (Figure 5). Upon receiving a low water level signal, the low pressure ECCS pumps will start if either the low RPV pressure permissive or the bypass timer is satisfied. This logic arrangement maintains the same design philosophy of eliminating the potential for unnecessary ECCS pump starts at high reactor pressure. It is also compatible with Option 4 of the ADS modification because the same bypass timer could be used to initiate the ECCS pumps. Feasibility of implementing MOD A or MOD B of the pump start logic to either Options 2 or 4 is evaluated below.

2.3 EVALUATION OF PUMP START MODIFICATIONS

The potential modifications for the ADS logic and the ECCS pump start logic for the listed plants are as follows:

(1) Option 2A* - Eliminate the high drywell pressure permissive of the ADS and the low RPV pressure permissive of the ECCS pump start (Figure 6).

(2) Option 2B - Eliminate the high drywell pressure permissive of the ADS and add a bypass timer for the low RPV pressure permissive of the ECCS pump start (Figure 7).

(3) Option 4A - Add a bypass timer for the high drywell pressure permissive of the ADS and eliminate the low RPV pressure permissive of the ECCS pump start (Figure 8).

(4) Option 4B - Add a bypass timer for the high drywell pressure permissive of the ADS and for the low RPV pressure permissive of the ECCS pump start (Figure 9).

The feasibility of implementing each option for the listed plants is presented below.

2.3.1 Option 2A

Implementing MOD A of the ECCS pump start with Option 2, i.e., Option 2A (Figure 6), of the ADS modification may not be desirable for plants with one common water level initiation for the high pressure ECC systems, low pressure ECC systems, and ADS. This is because the ADS could be initiated after two minutes on a low water level signal unless (a) the operator intervenes by resetting the two minute timer or activating the

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* 2A refers to Option 2 with Modification A.

ADS inhibit switch or (b) the high pressure ECC systems or other water injection systems can clear the low water level signal during the two minute interval.

For those plants with the high pressure ECC systems initiation at a higher water level, additional time is available to recover the water level before the ADS two minute timer is initiated. For those plants in Table 1, only two minutes is available. The two minute period is judged to be marginal to assure that ADS will not initiate on one signal only during a transient event which may not require rapid depressurization.

2.3.2 Option 2B

A new bypass timer would be required for Option 2B, i.e., incorporating MOD B with Option 2 of the ADS modification (Figure 7). The delay setting of the bypass timer would be approximately 10 minutes. The exact delay setting should be determined by a detailed analysis. The 10 minute delay would be sufficient to allow the operator to inhibit ADS if the event does not require rapid reactor depressurization. The bypass timer would automatically reset if the water level is restored. With the bypass timer, the logic is essentially the same as Options 4A and 4B (discussed below).

2.3.3 Option 4A

Figure 8 shows MOD A of the ECCS pump start combined with Option 4 of the ADS modification. In Option 4A, the low water level signal would start the low pressure ECCS pumps and the bypass timer. For those plants listed in Table 1, the delay setting for the bypass timer would be approximately 10 minutes; the exact delay setting should be determined by a detailed analysis. This long bypass duration should be sufficient to allow the operator to inhibit ADS if necessary.

Option 4A is essentially the same as the Option 4 logic for BWR/4-6. The only exception is that the bypass timer will automatically reset if the water level is restored. The reset is required because of the common water level initiation.

2.3.4 Option 4B

In Option 4B, the same bypass timer for the high drywell pressure signal would be used to bypass the low RPV pressure signal (Figure 9). As in Options 2B and 4A, the long duration of the bypass timer also allows operator action to inhibit ADS for events which do not require rapid RPV depressurization. The Option 4B logic arrangement is similar to Option 2B except that the high drywell pressure permissive in the ADS logic is maintained in Option 4B. Although all options could initiate ADS with a sustained low water level signal, the high drywell pressure signal could provide a direct and timely ADS and low pressure ECCS pump initiation for a break inside the drywell. Therefore, Option 4B has this additional advantage over Option 2B. The Option 4B logic arrangement is also similar to that of Option 4A with the exception that the ECCS pump start in Option 4B would not occur until the bypass timer times out. This allows more time for the high pressure systems to function and clear the low water level signal to prevent unnecessary pump start of the low pressure ECC systems. Therefore, the advantages of the Option 4B logic are that this logic arrangement is consistent with the original design concepts of the ECCS pump start logic and with the Option 4 of the ADS modification.

3. SUMMARY AND CONCLUSIONS

To satisfy the intent of minimizing the reliance on operator actions for certain events for plants which have a low RPV pressure permissive coincident with low water level for the low pressure ECCS pump start logic, four possible modifications of the ADS and the ECCS pump start logic were evaluated. These four modifications are entitled Options 2A, 2B, 4A, and 4B. All options considered would meet the objectives of extending ADS operation to transient events which do not result in a release of steam to the drywell but which may require depressurization of the reactor pressure vessel to maintain adequate core cooling. However, some options are more prone to spurious or premature ADS in situations where ADS may not be necessary. The high and low pressure ECC systems are initiated on a common low water level signal for the plants evaluated (See Table 1) Hence, ADS could be initiated after two minutes with Option 2A without operator intervention. Therefore Option 2A, which eliminates the high drywell pressure permissive of the ADS and the low RPV pressure permissive of the ECCS pump start, is found to be least desirable for the plants listed in Table 1. The other three options appear considerably better because of the additional time available for water level recovery. Option 4B has an advantage over Option 2B in that it maintains the high drywell pressure permissive in both the ADS and low pressure ECCS pump logics. The high drywell pressure permissive would provide a direct and timely initiation of ADS and low pressure ECCS pump for a break inside the drywell. Option 4B also has an advantage over Option 4A in that some unnecessary starts of the low pressure ECCS pumps may be avoided, consistent with the original design of the pump start logic.

TABLE 1

PLANTS WITH LOW RPV PRESSURE PERMISSIVE

FOR ECCS PUMP START

Dresden 2 and 3

Millstone

Monticello

Pilgrim

Quad Cities 1 and 2

Vermont Yankee

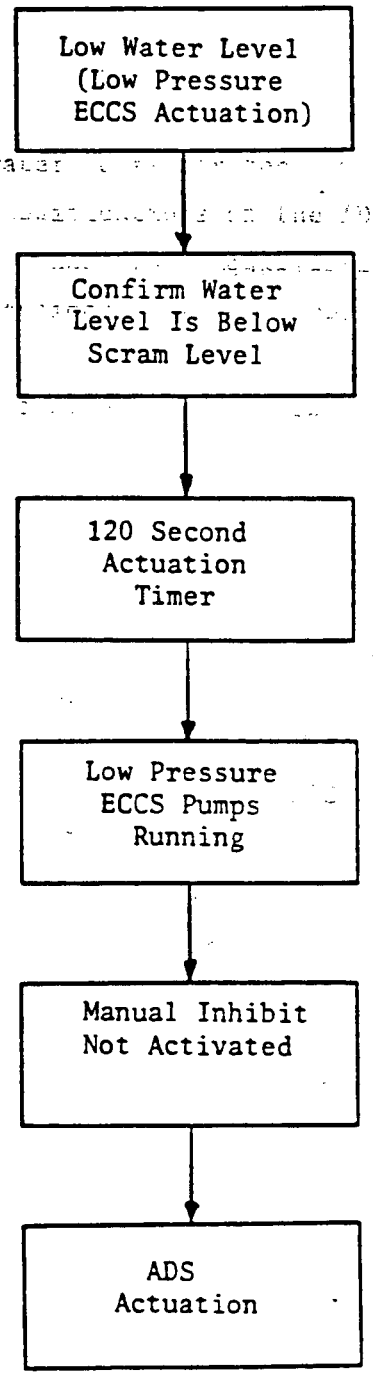


Figure 1. ELIMINATE HIGH DRYWELL PRESSURE TRIP AND ADD MANUAL INHIBIT SWITCH (OPTION 2)

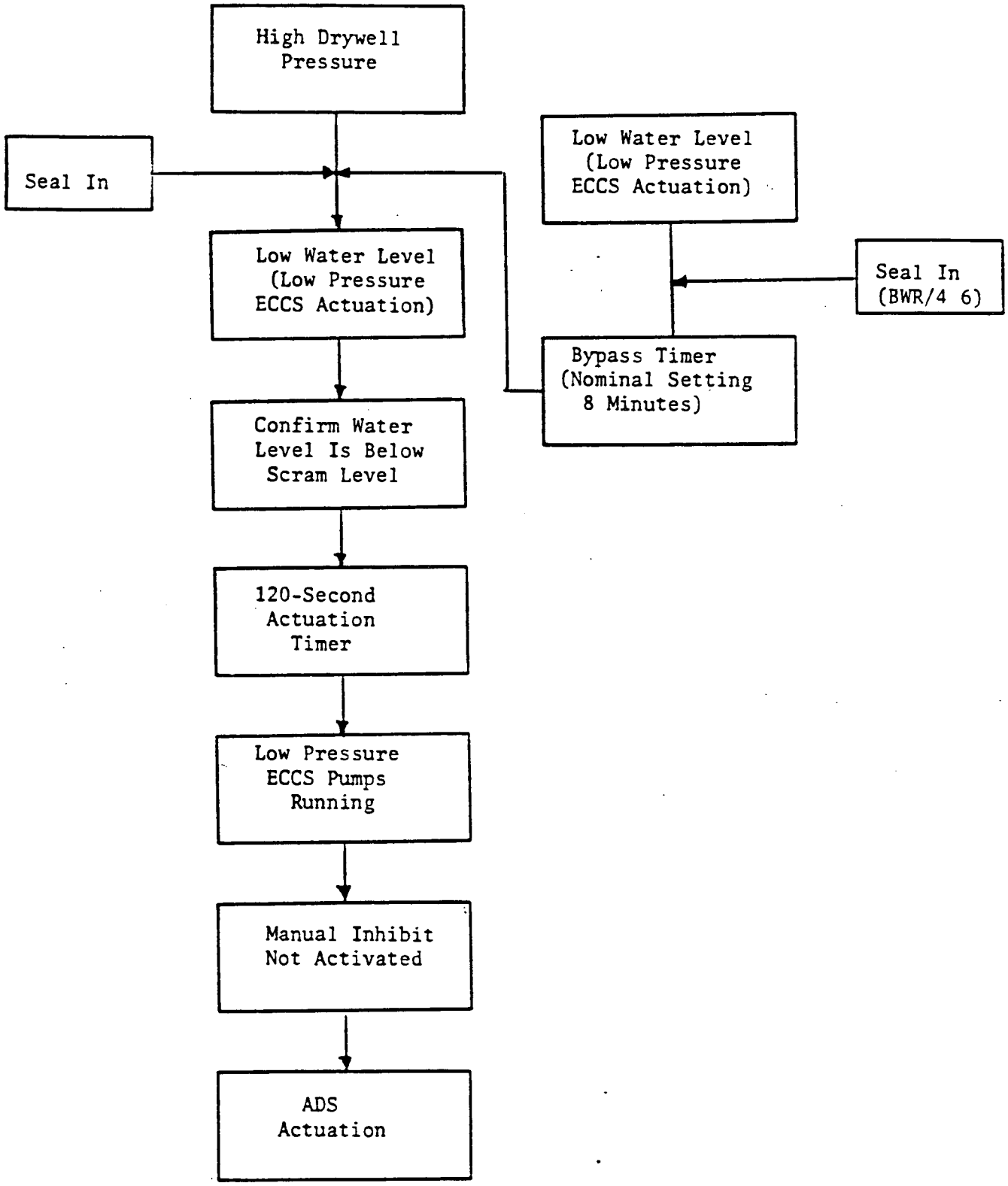


Figure 2. BYPASS HIGH DRYWELL PRESSURE TRIP AND ADD MANUAL INHIBIT SWITCH (OPTION 4)

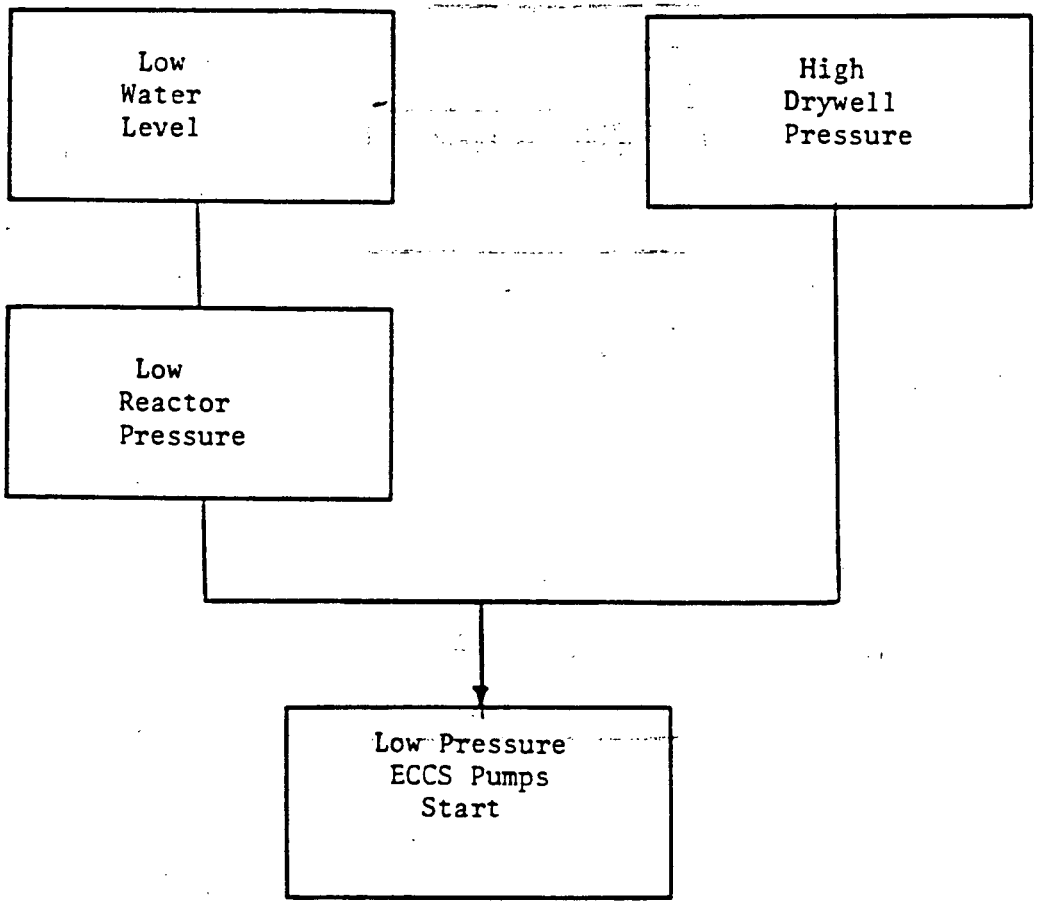


Figure 3. EXISTING PUMP START LOGIC FOR LISTED PLANTS

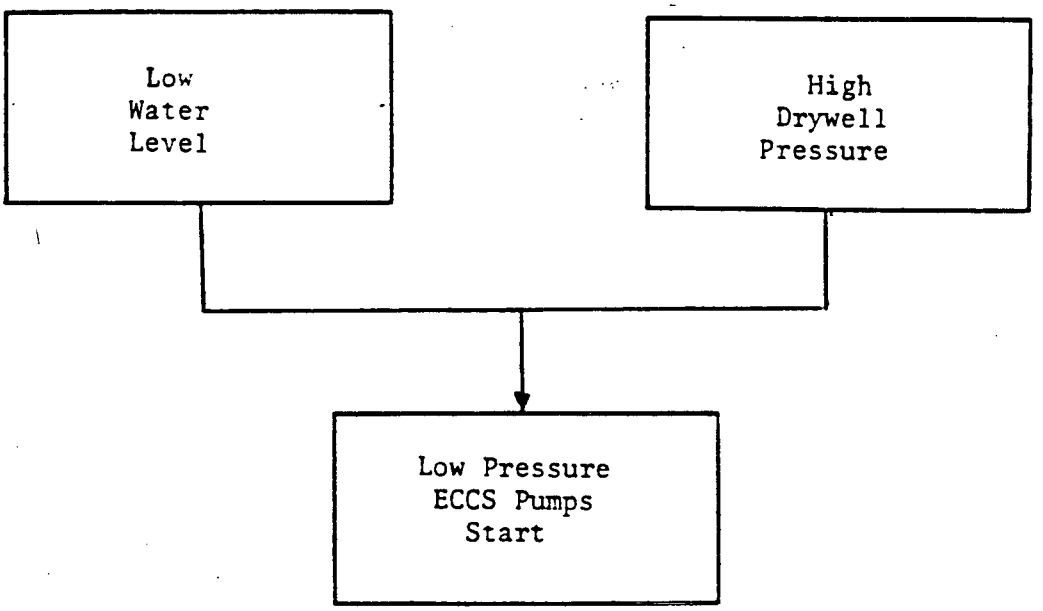
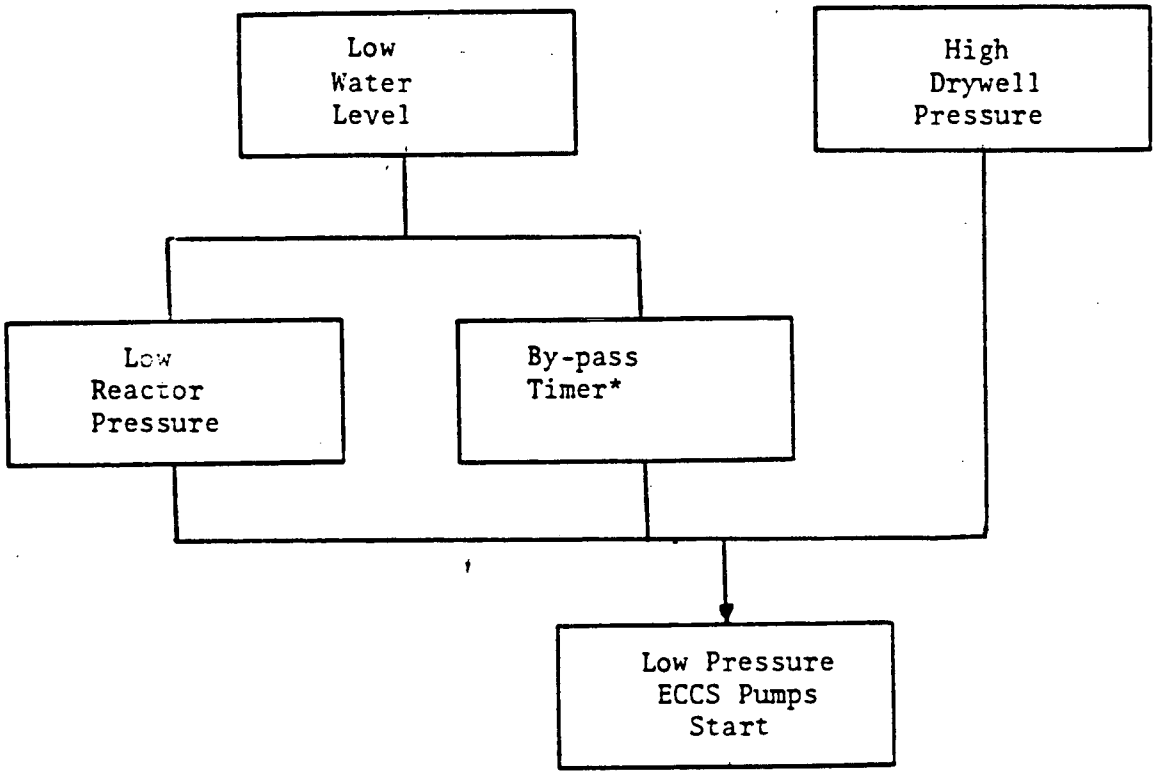


Figure 4. MOD A OF ECCS PUMP START LOGIC



* Nominal Setting Approximately 10 Minutes

Figure 5. MOD B OF ECCS PUMP START LOGIC

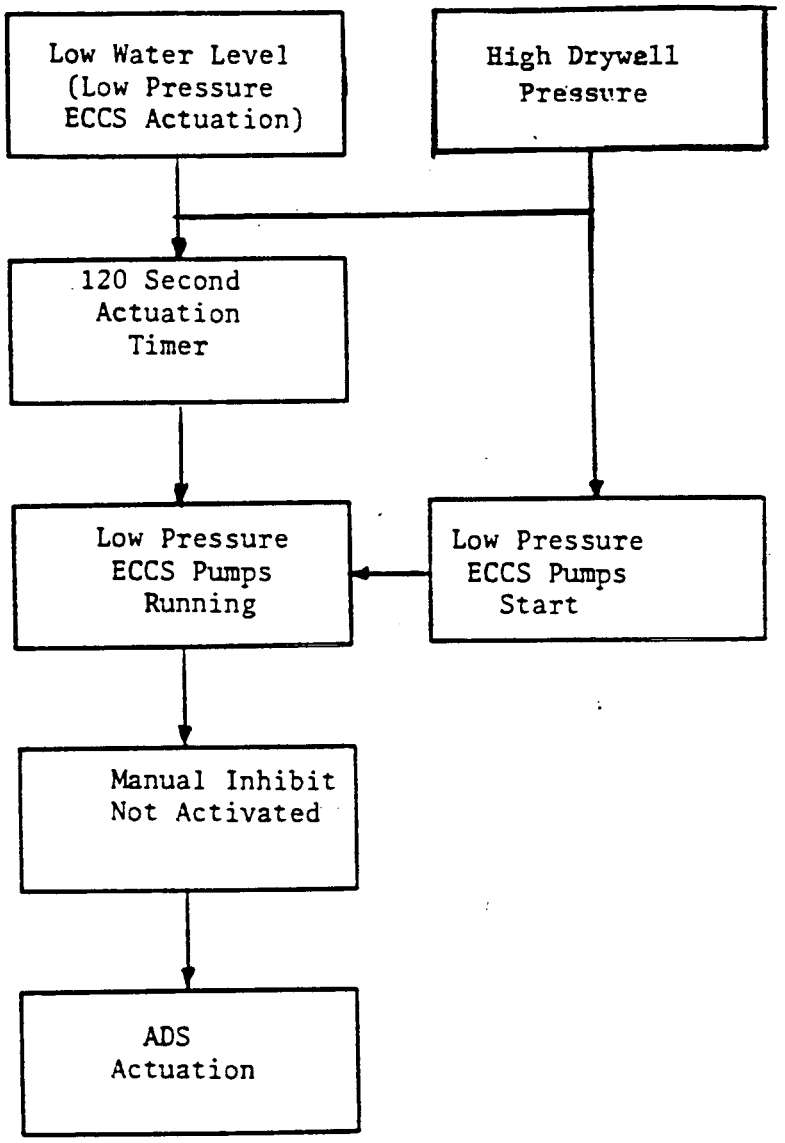


Figure 6. OPTION 2A (Eliminate High Drywell Pressure Permissive for ADS and Low Reactor Pressure (Permissive for ECC Pumps)

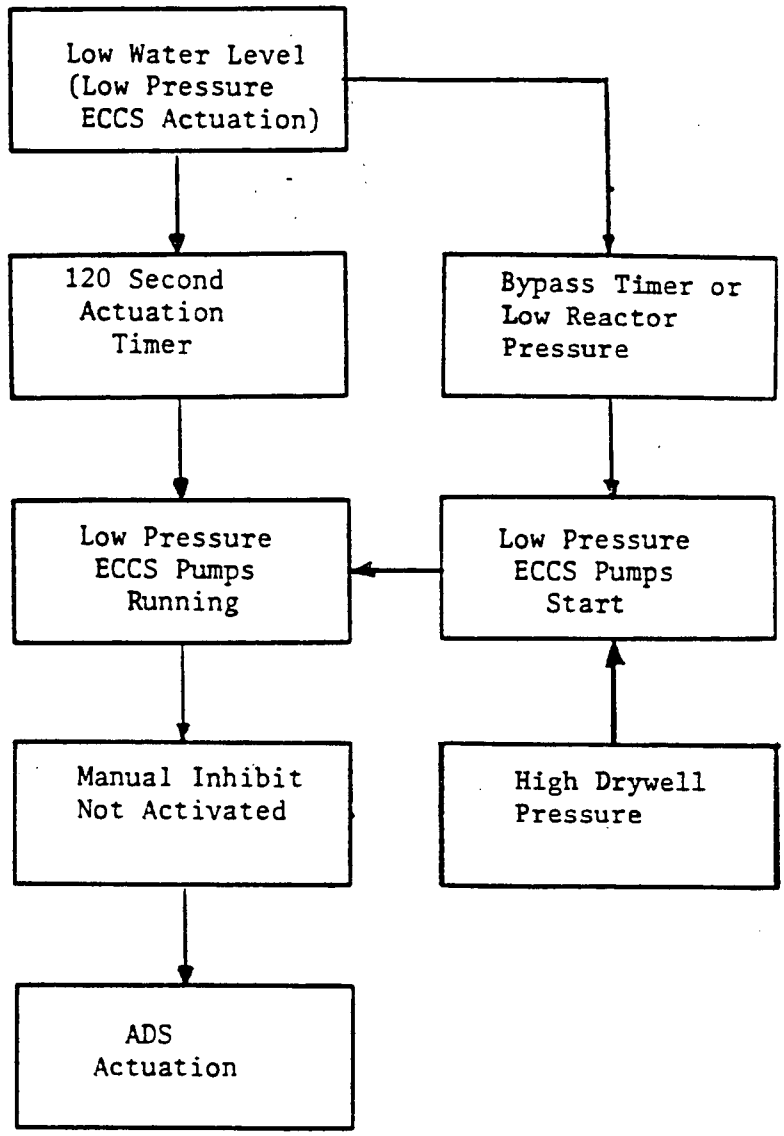


Figure 7. OPTION 2B (Eliminate High Drywell Pressure Permissive of ADS and Add a Bypass Timer For the Low RPV Pressure Permissive of Low Pressure ECCS Pump)

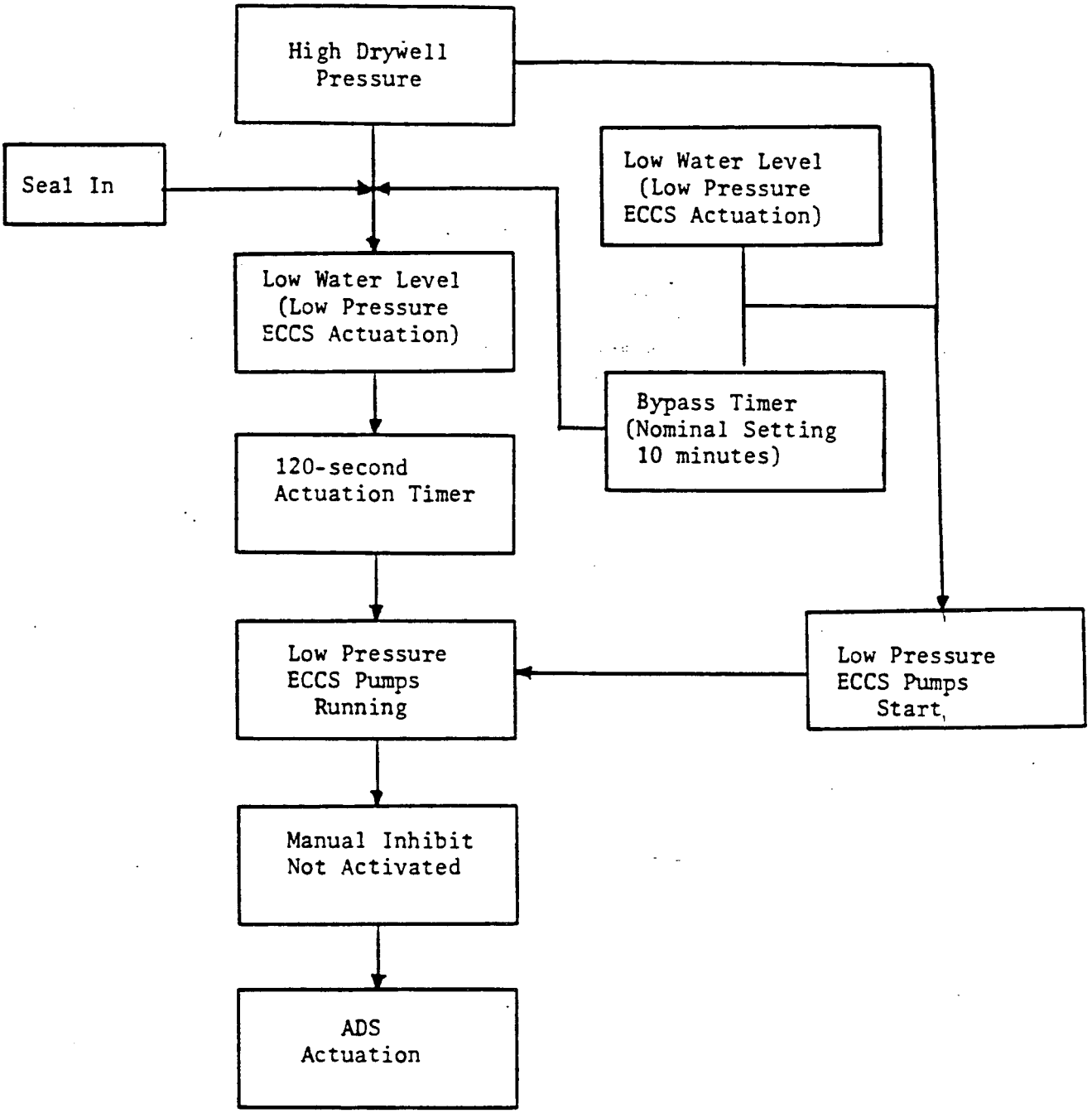


Figure 8. OPTION 4A (Add Bypass Timer For the High Drywell Pressure Permissive of ADS and Eliminate Low RPV Pressure Permissive of Low Pressure ECCS Pump)

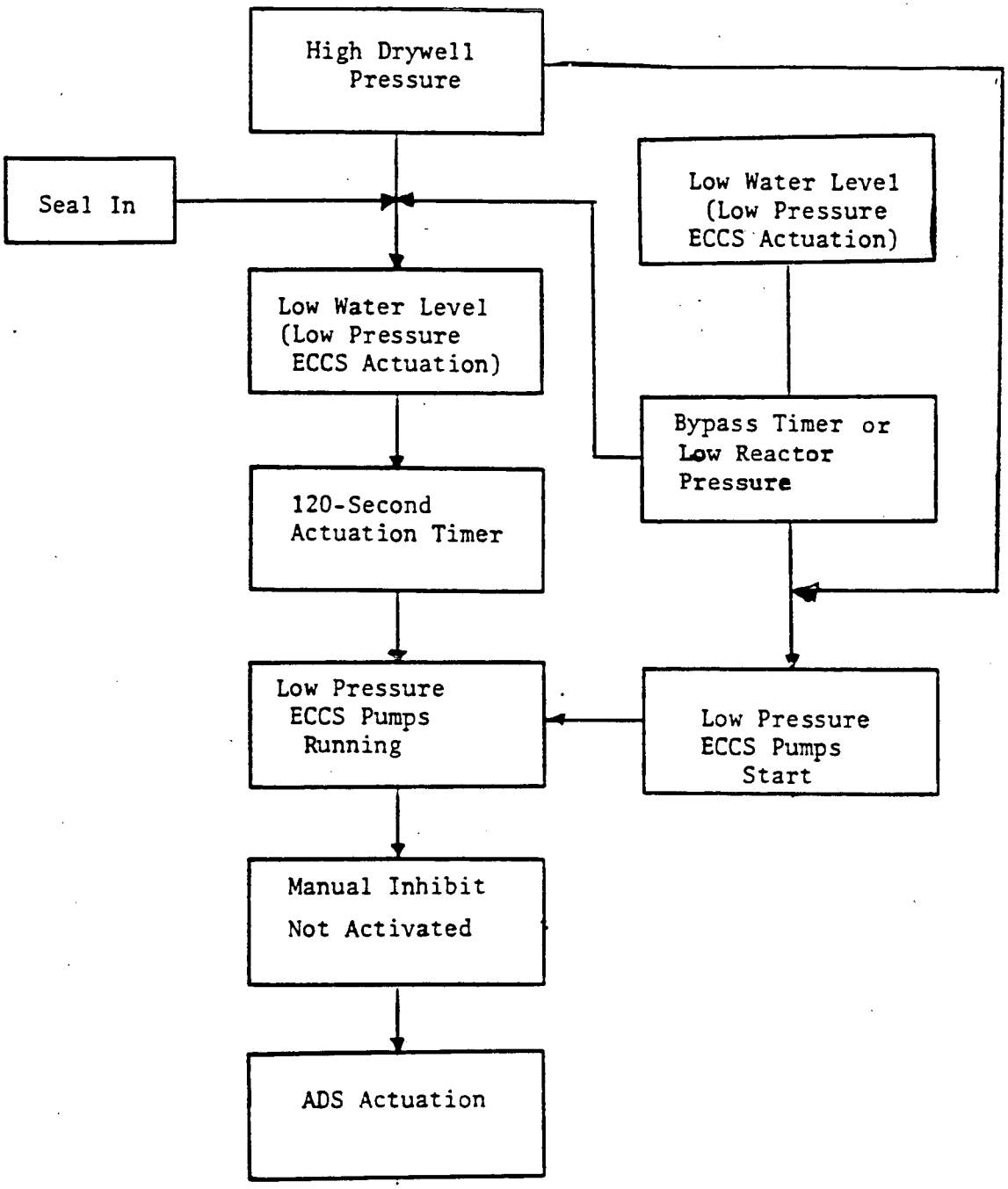


Figure 9. OPTION 4B (Add Bypass Timer For the High Drywell Pressure Permissive of ADS and to the Low Pressure ECCS Pump)