The figure 2.10 illustrates flow chart of methodical process of applying ARIZ to solving secondary problem, tertiary problem or n^{th} problem until solution is found. Practically, ARIZ is recurrent approach of repetitively applying I-TRIZ for producing a phenomenon. As showed in the figure 2.10, simple approach of I–TRIZ is formulate a problem, identify a method by searching solution from repositories of information, and synthesize a phenomenon with respect to identified method using resources around a system. The first five steps of the flow chart is typically I-TRIZ method beside the step, recap the problem. ARIZ method for AFD comprises these steps:

- *Recap a problem*

- *Formulate secondary problem*

- *Formulate Ideal solution of the problem*

- *Search ways to achieve the solution*

If the first the solution is completely solved, it means there is a latent resources that should be found; then, formulate tertiary problem and continue in the loop until solution is revealed.

STEP 6: HYPPTHESIZE THE SOLUTION AND VERIFY IT

In step 6, hypothesis of how a failure (problem) occurs is formulated and systematic approach on how to prove validity of the hypothesis are stated and proved.

Step 7: CORRECT THE FAILURE

Present remedies for preventing or eliminating failure. Principle of maximum use of resources is applicable here to correct a failure.

2.4.7 I-TRIZ Based AFD-2 Template

AFD-2 is failure prediction analysis. This method embodies framework that is very important in safety system design as it shows forward method and backward method of predicting all possible failures of a system before they occur, which is crucial for preventing them before they impact damages. This method is recurrent application of AFD-1 concepts. Its template is shown in the following.

STEP 1: FORMULATE THE PROBLEM

In this step, formulate the problem, which can be stated as: predicting all possible system failures and synthesizing the predicted failures. Importance of focusing on predicting all possible system failures and synthesis those failures as original problem in AFD-2 approach is due to necessity to predict them, synthesize them, understand their mechanisms and prevent them before they occur.

STEP 2:DESCRIBE THE SYSTEM SUCCESS SCENARIO, S_0

Describe system phases, success scenarios of its phases $\{S_{p_1}, S_{p_2}, S_{p_3}, \ldots, S_{p_n}\}$, and success scenario of the system, S_0. This is similar to step 2 of AFD-1.

STEP 3: FORMULATE THE INVERTED PROBLEM

In this step, invert the problem as in AFD-1 template; in AFD-2, the inverted problem should read as thus: *"synthesizing all the possible failures that can appear as result of the system interactions."*

STEP 4: FIND OBVIOUS IE, ES, and MS

Find obvious initiating events, harmful end states and mid states of the system by applying concept of FMEA and HAZOP; applying the two RA methods reveals most obvious initiating events $\{IE_j\}$, mid-states $\{MS_j\}$) and harmful end states $\{HES_j\}$; organize those $\{IE_j\}$, $\{MS_j\}$, and $\{HES_j\}$ in scenario trees for clarity.

STEP 5: FIND OR LOOK FOR LATENT FAILURES

Conduct survey of resources around and within the system and map out possible resources that can cause system failures; then, find latent or unobvious failure scenario by focusing on failure mechanism that can be initiated by those resources. AFD software can help in conducting such survey because it has package specialized for that.

STEP 6: STUDY AFD CHECKLIST

In step seven, AFD-2 approach suggests studying checklists, which are embedded in AFD software for possibility of finding scenarios. The scenarios that are found in this step should be added to scenario tree. The AFD checklists are appended for references.

STEP 7: DRAW INCOMING TREES TO END STATES

Seventh step of AFD-2 template demands that you draw incoming trees to connect the found initiating events, mid states, and end states, which is helpful for building scenarios through which harmful end states can occur. Since AFD-2 purpose is to find all possible failures and scenarios, try to identify other ways through which the found events can occur; in this case, AFD software and ARIZ are good supports for identifying other scenarios. In this step, worsen the harmful end states to whether other scenarios can result from that. If some scenarios result from worsening the HES's, draw incoming trees to account for them in the scenario trees.

STEP 8: STATE CORRECTIVE MEASURES

In this step, use I-TRIZ operators to recommend measure.