Entergy

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May 3, 2007

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U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555-0001

SUBJECT: Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No. 50-293
License No. DPR-35

Additional Information Concerning Revised Request for Authorization under the Provision of 10 CFR 50.55a(a)(3)(i) for Modification of Core Shroud Stabilizer Assemblies (TAC NO. MD4918)

REFERENCES: 1. Entergy Letter No. 2.07.042, Revised Request for Authorization under the Provision of 10 CFR 50.55a(a)(3)(i) for Modification of Core Shroud Stabilizer Assemblies (TAC NO. MD4918), dated April 29, 2007.

LETTER NUMBER: 2.07.045

Dear Sir or Madam:

By Reference 1, Entergy requested NRC authorization under the provisions of 10 CFR 50.55a(a)(3)(i) for a pre-emptive modification of the core shroud stabilizer assemblies during refueling outage (RFO) 16. This letter provides additional information identified as needed during discussions with the NRC Staff to support the review of the request.

There are no regulatory commitments made in this submittal.

NRC authorization to use this proposed alternative is requested on or before May 5, 2007 to support the scheduled startup of Pilgrim following RFO-16.

If you have any questions or require additional information, please contact Mr. Bryan Ford, Licensing Manager, at (508) 830-8403.

Sincerely,

Stephen J. Bethay

Stephen J. Bethay

A047

Attachment: 1. Additional Information In Support of Proposed Core Shroud Stabilizer Assembly Configuration (11 pages)

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Additional Information In Support of Proposed Core Shroud Stabilizer Assembly Configuration

RAI 1

What are acceptable limits discussed in page 5 Item 1?

RESPONSE

Acceptable limits are the Design Basis ASME Section III Allowable stress limits for Normal, Upset, Emergency, and Faulted Conditions.

RAI 2a

What is the maximum rotation considering the design and failure of the torsion arm bolt?

RESPONSE

The torsion arm assembly and torsion arm clamp are shown in Figures 1, 2, 3, and 4.

The nominal rotation is 4.2°. Considering the tolerances, the maximum rotation is 5° in each direction

RAI 2b

Does the assessment of page 6 (iii) consider the maximum rotation from question 2a?

RESPONSE

The subject assessment was performed considering the nominal rotation of 4.2°. However, adequate margin in the stresses exists to offset a slight increase in the stresses due to the maximum rotation of 5°.

RAI 3

Page 7, 5th Bullet: Is there any way of inspecting the threads on the shank on the torsion arm bolts in location 135° and 315° (assemblies without clamps).

RESPONSE

As discussed in Reference 1 Section 4.1, the torsion arm bolt was inspected by EVT-1 on all four (4) core shroud stabilizer assemblies with no indications of cracking. This EVT-1 inspection was limited to the accessible portions of the bolt on all four (4) assemblies.

No inspection method was available to perform inspections of the inaccessible portions of the bolts to determine if cracking was occurring. Entergy summarized the results of the evaluation for the potential failure of the torsion arm bolts due to cracking in Reference 1 Section 3.2. This review determined that the upper stabilizer assembly design is not adversely affected by not installing the torsion arm clamp and that reactor safety is not impacted for one cycle by the potential release of loose parts.

RAI 4

Can the clamps be installed on the 135° and 315° tie-rod assemblies?

RESPONSE

Installation of the torsion rod bolt clamps is not feasible on the unmodified 135° and 315° core shroud stabilizer assemblies during this refueling outage. As discussed in Reference 1, the upper supports at 45° and 225° azimuths were successfully modified including the installation of the torsion arm bolt clamps. Due to installation difficulties with tooling, it was decided not to replace the upper supports at the 135° and 315° azimuths. These tooling difficulties also impact the ability to install the torsion arm bolt clamps. The clamp installation design was based on the replacement of the upper supports. In addition, the supplied torsion arm bolt clamps experienced fit up issues that required them to be field measured and re-machined to successfully install the clamps on the modified assemblies. Therefore, it is not feasible to install the clamps on the unmodified core shroud stabilizer assemblies during this refueling outage.

RAI 5

Loose Parts Analysis Summary;

a. Identify the size of loose parts that can be generated with failure of the torsion arm bolt.
b. Identify the locations in the reactor coolant system where the loose parts could migrate
c. Explain why loose parts at the locations in (b) are not a safety concern
d. Why are clamps installed on 45 and 225 locations?

RESPONSE

Reference 1, Section 3.2(iv) provided a summary of the loose parts analysis performed which determined that potential loose parts generated by a failure of a torsion arm bolt would not impact reactor safety.

The evaluation performed was consistent with BWRVIP-06A, Safety Assessment of BWR Reactor Internals, Section 4.1. The evaluation considered if the potential loose parts could represent a safety concern by evaluating if they result in (a) the potential for bundle flow blockage and consequential fuel damage, (b) the potential for interference with control rod operation, or (c) the potential for corrosion and chemical interaction with other reactor materials. The following provides additional details of the analysis.

If the torsion arm bolt failed, there is the potential for loose parts to be generated. The potential loose parts for each bolt failure consist of:

- Two (2) torsion arms (approximate size is 13-3/4" length X 1-3/4" width on one end tapering to a width of 0.4" X 0.4" thickness at one end and 7/8" on the larger end),

- One (1) torsion arm bolt (approximate size is 1/2" diameter X 4" length with a 1-1/4" head diameter),

- One anti-rotation pin (approximately 1/8" diameter by 3/4" long).

The material of all of the potential loose parts with the exception of the small pin is Alloy X-750. The pin is type 316/316L stainless steel.

The potential loose parts could come to rest at the Jet Pump support plate in the annulus, or become entrained in the recirculation system flow and migrate into the lower plenum. Since the High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) systems inject through the normal feedwater injection path, the potential loose parts cannot migrate and impact these systems due to the force of normal feedwater flow.

The torsion arms would come to rest in the bottom head, but the bolt and pin could possibly be lifted with the flow and migrate into a fuel support casting and potentially reach the lower tie plate of the fuel bundle. The bolt and pin are too large to pass through the lower tie plate and reach the fuel rods. Another potential migration path considered for the smaller size pin is that it could enter the Reactor Water Cleanup (RWCU) system piping through the bottom head drain.

The potential loose parts may impact components or vessel internals such as jet pump sensing line, core spray header supply line, lower core plate, or standby liquid control (SBLC) line causing some minor damage. This impact would not cause significant damage (e.g., breach the lines) due to the small size of the parts.

Although highly unlikely, the flow in the lower plenum could lift the pin and bolt parts to a fuel orifice. The pin and bolt are larger than the openings in the lower tie plate (LTP) and; therefore, will not pass through. The maximum possible blockage by these parts at the LTP would be significantly lower than the blockage necessary to cause boiling transition. Therefore, there is no concern for potential significant fuel bundle flow blockage and consequential fuel damage.

The potential loose parts are too large to pass through the LTP clearances and migrate any further in the RPV. Since there is no direct credible path from the lower plenum into the Control Rod Drive Guide Tube, the loose parts cannot interfere with operation of the CRD mechanism, and there is no potential for interference with control rod operation during normal rod withdrawal, insertion or the potential to interfere with the scram function.

Additionally, since the potential loose parts are too large to pass through the LTP and migrate any further in the RPV, they cannot affect the operation of equipment or systems connected to the main steam lines. This equipment includes the Main Steam Isolation Valves (MSIVs) and Safety Relief Valves (SRVs) or the HPCI system and RCIC system steam inlets.

Stainless steel and Alloy X750 are used in many components in the reactor pressure vessel and at many locations welded directly to low alloy steel or carbon steel with no evidence of corrosion or adverse chemical reaction with other reactor materials. Also, the low conductivity demineralized water does not contain significant quantities of ions that would accelerate galvanic corrosion effects. Therefore, there will be no significant corrosion or adverse chemical reaction with other reactor materials from the potential loose parts.

There is a slight operational concern related to the potential for partial bottom head drain plugging which can be detected and mitigated through existing procedures. The bottom head drain does not perform a safety function. There are no operational concerns relative to the potential for fuel damage due to fretting, or to interference with operation of the non-safety related RWCU system (e.g., RWCU pump, heat exchangers, or filter demineralizers). The larger torsion arms could cause some impairment of the non-safety related recirculation system performance or damage to the recirculation system components (operational concern) if they are entrained in the recirculation system flow.

The possibility of potential loose parts acting in conjunction with another loose part to cause or aggravate a design or operational concern is an extremely low probability event and was not evaluated.

The evaluation determined that reactor and associated system design requirements will not be compromised with the presence of the potential loose parts in the reactor vessel. There is no design concern for flow blockage to the fuel bundles (no blockage of orifices to the fuel and minimal blockage of fuel lower tie plate debris filter, no interference with the scram function (parts cannot migrate to the control rods or control rod drive (CRD) guide tubes), no corrosion or adverse chemical reaction with other reactor materials, no interference with Nuclear Boiler or Neutron Monitoring Instrumentation, no interference with Residual Heat Removal (RHR) pumps or heat exchangers, or interference with RWCU or RHR isolation valves.

Entergy's review determined that the unmodified upper stabilizer assembly design is not adversely affected by not installing the torsion arm clamp and that reactor safety is not impacted by the potential release of loose parts. The potential operational issues, though acceptable for one cycle, are not an acceptable business risk for the remaining life of the plant if there is an available method to mitigate the concern. Therefore, it was decided to install the torsion arm bolt clamps when feasible. Entergy plans to install the full modification on the 135° and 315° core shroud stabilizer assemblies during RFO 17.

RAI 6

Provide justification for allowing operation for one cycle with flaws in X-750 components in tie rod upper supports (135° and 315° locations) and torsion arm bolt where access for examination is limited.

RESPONSE

The two X-750 components of concern for IGSCC in each core shroud stabilizer assembly are the core shroud stabilizer assembly upper support and the torsion arm bolt.

As discussed in Reference 1, Section 3.2 and responses to the RAIs preceding, Entergy determined that the upper stabilizer assembly design is not adversely affected and that reactor safety is not impacted by the release of loose parts due to the potential failure of the torsion arm bolt by IGSCC.

For the core shroud stabilizer assembly upper support there is reasonable assurance that the unmodified core shroud stabilizer assembly upper supports are not flawed. Reference 1 provides the basis for this determination and includes the following supporting evidence:

1. The two (2) removed upper supports were inspected by EVT-1 on the tops, sides, and normally inaccessible undersides and there were no indications of cracking.
2. The two (2) upper supports remaining in service were inspected by EVT-1 on the tops and sides and there were no indications of cracking.
3. The stresses for the Pilgrim supports are significantly lower than the stresses calculated for the plant where cracking was found on two (2) of the eight (8) inspected supports (Reference 1, Table 1, Plant A).
4. The stresses for the Pilgrim supports are significantly lower than the stresses calculated for another plant where the supports were inspected on the underside and had no evidence of cracking (Reference 1, Table 1, Plant B).
5. A refined stress analysis indicates that the actual stresses in the Pilgrim supports are lower than the stress previous identified in the GE Part 21.
6. Nine (9) plants have inspected the supports using EVT-1 inspection methods. Except for the one plant, none of those inspections have detected any crack indications as indicated in the table (Reference 1, Table 1).

Although, sufficient basis exists to provide assurance that the two (2) core shroud stabilizer assembly upper supports remaining in service have not experienced IGSCC, defense in depth reviews have been performed of the core shroud integrity and potential flaw propagation in a core shroud stabilizer assembly upper support.

As described in Reference 1, Section 3.1(ii), the BWR fleet experience provides evidence that the core shroud welds retain their structural integrity without the tie rod repair. In addition, the shrouds contain both vertical and horizontal welds, inspections and re-inspections of vertical welds have been performed. For Pilgrim, the recent inspections performed this outage continue to confirm the absence of cracking in the vertical welds. The absence of cracking, in conjunction with HWC, provides indirect evidence and a high degree of confidence that the shroud's horizontal welds retain their structural integrity as well. Additionally, the implementation of HWC/NMCA effectively mitigates the propensity for IGSCC cracking, further assuring that any cracked regions at the welds will not increase significantly.

To provide further confidence that a core shroud stabilizer assembly is not compromised by this issue; analytical efforts were also performed to evaluate crack growth of an assumed IGSCC indication hidden from external view in the support. The focus of this scoping study was to evaluate the growth and resultant crack depth that would occur over one operating cycle. A summary of the analysis approach, assumptions, and results follow. Based on the specific cases evaluated, the resulting predicted crack size present in the support after one cycle was found to be acceptable.

The crack growth analyses that have been performed employed the results from the finite element model (FEM) of the existing Alloy X-750 tie rod upper support that was generated to better understand the stresses in the tie rod support. The model represented the Pilgrim geometry including the pads on the upper support, plasticity in the stainless steel shroud and X-750 upper support, and contact between the shroud ledge and upper support. The PROPLIFE Code was used in conjunction with the finite element analysis (FEA) results to predict the crack depth and length as a function of time.

Using the model of the support, two cases were evaluated: (1) a semi-circular starting flaw located at the center of the support and (2) an elliptical starting flaw located at one edge. The two cases are considered to bound the crack growth behavior of all expected crack initiation locations given the starting flaw size assumptions. The center flaw provides the most conservative estimate of crack growth because the flaw can grow in both directions. The corner flaw gives the upper bound life assessment. The stress distribution observed in the upper support shows that flaw initiation is expected somewhat off center along the raised pads. This result does indicate that cracking would be visible on one of the two sides first. Using the assumed starting flaws, the Normal Water Chemistry (NWC) crack growth relationship given in BWRVIP-138 (BWR Vessel and Internals Project, Updated Jet Pump Beam Inspection and Flaw Evaluation Guidelines) was used to propagate the indication both in the length and depth direction. This flaw growth rate may be conservative due to Pilgrim's implementation of hydrogen water chemistry and noble metal chemistry.

This NWC Alloy X-750 crack growth relationship used for the analysis is as follows:

$da/dt = 5.9 \times 10^{-9} \times K^{2.5}$ for $K<50$ ksi-in $^{1/2}$

and

$da/dt = 1.0 \times 10^{-4}$ in/ hr for $K \geq 50$ ksi-in $^{1/2}$

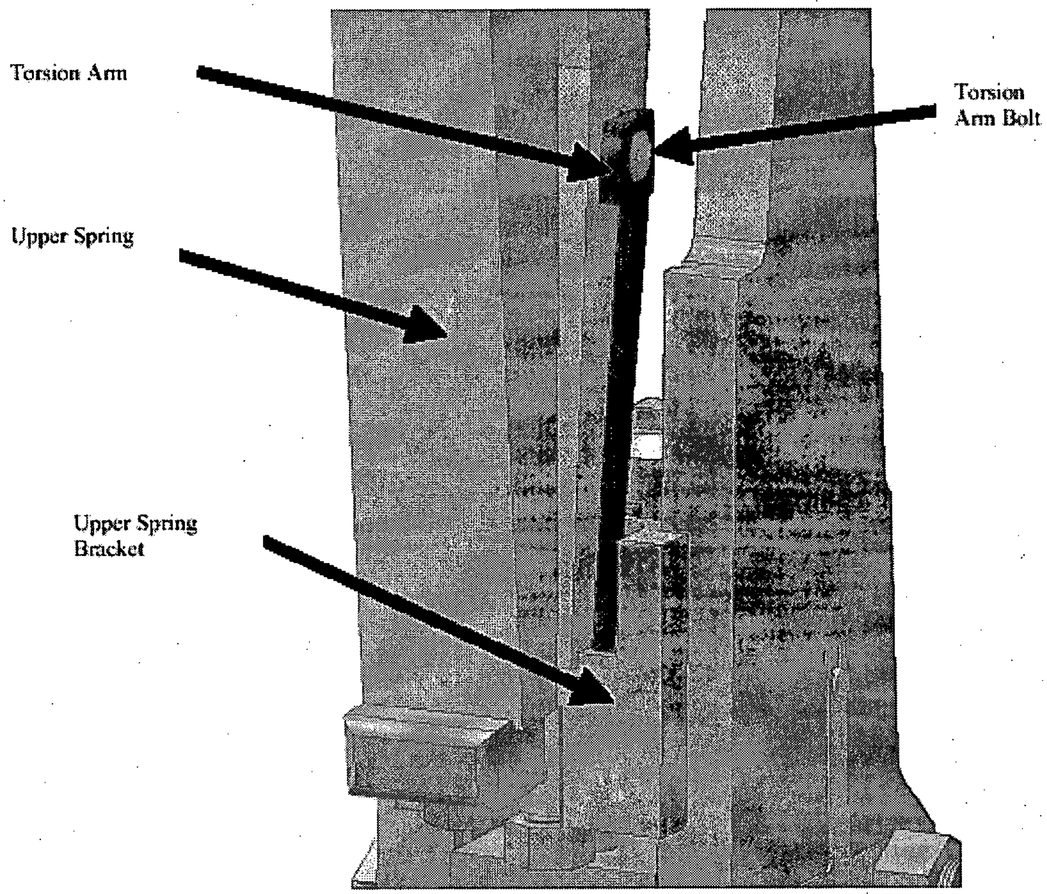
where da/dt is given in in/hr and K is the stress intensity factor given in ksi-in $^{1/2}$

The critical flaw size was calculated using the finite element model of the upper support. Multiple solutions were obtained using the FEM with through width flaws of progressively deeper dimensions. The elastic stress distribution through the vertical failure plane at the tip of these flaws was used to determine the applied force and moment on the remaining ligament. This was compared to the theoretical plastic collapse moment for a rectangular section. The allowable flaw size is defined as the flaw size at which the ASME required safety factors (3.0 for Level A/B and 1.5 for Level C/D) are just met. The allowable flaw size for the Pilgrim Upper Support used in this assessment was a 0.7" through width rectangular shaped flaw. The assessment of acceptability was based on the maximum depth of the elliptical shaped crack.

The results of the PROPLIFE calculations for the two different crack locations were then evaluated. The center indication with a starting size of 0.2 inches deep by 0.4 inches long was found to be acceptable after one cycle (17520 hours) of operation. Similarly, the corner indication of 0.2 inches deep by 0.4 inches long was also shown to be acceptable for one cycle. This corner flaw was predicted to grow more slowly than the center flaw. These analyses confirmed that the upper supports are acceptable for one cycle of operation even if some undetected IGSCC initiation has occurred.

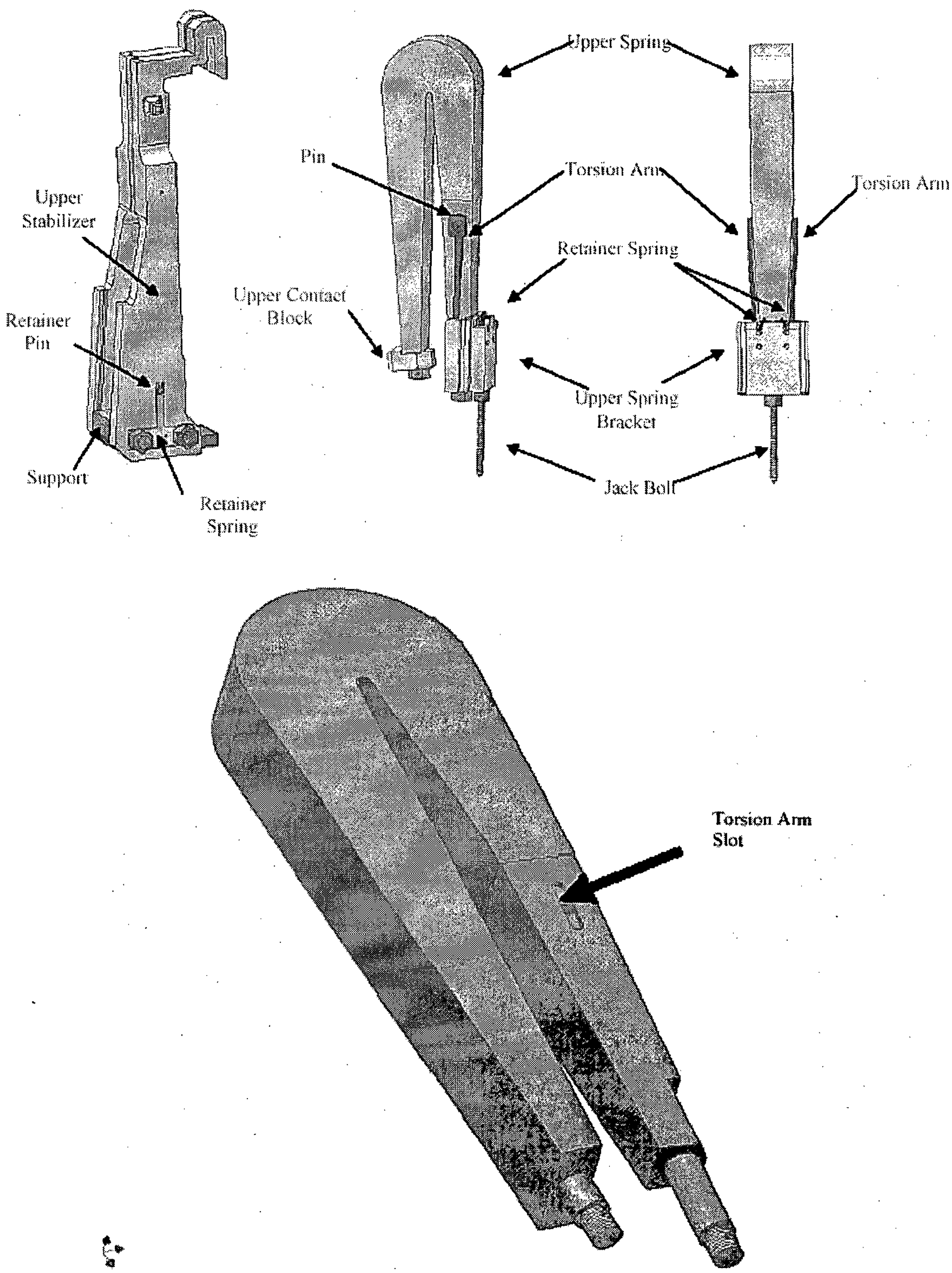
References

1. Entergy Letter No. 2.07.042, Revised Request for Authorization under the Provision of 10 CFR 50.55a(a)(3)(i) for Modification of Core Shroud Stabilizer Assemblies (TAC NO. MD4918), dated April 29, 2007.



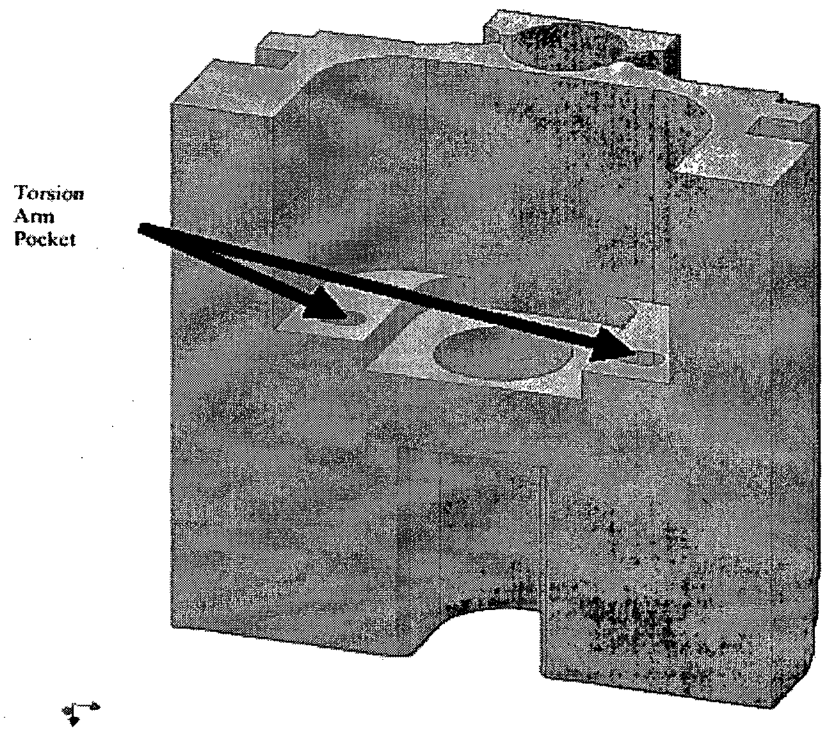
Upper Spring to Upper Spring Bracket Connection

Figure 1

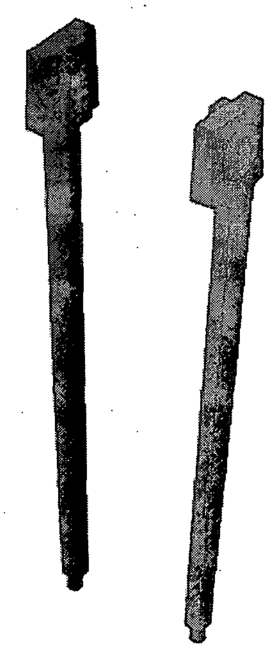


Upper Spring

Figure 2



Upper Spring Bracket



Torsion Arms

Figure 3

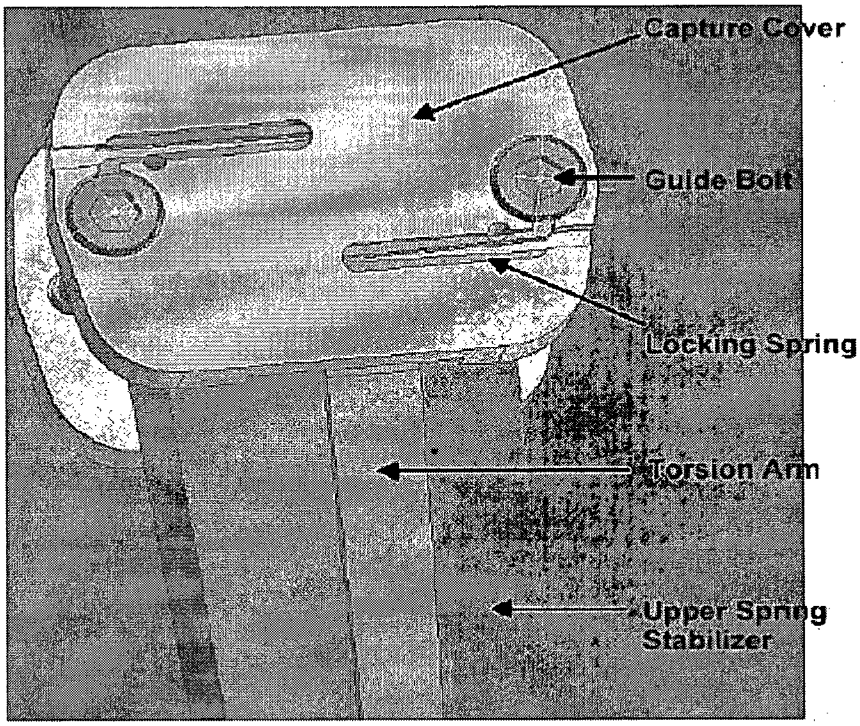

Capture Cover
Guide Bolt
Locking Spring
Torsion Arm
Upper Spring
Stabilizer

Figure 4