



ENGINE SYSTEMS, INC.

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August 22, 2019

50-220/410

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

Subject: 10CFR21 Reporting of Defects and Non-Compliance -
Engine Systems, Inc. Report No. 10CFR21-0126, Rev. 0

EMD Fuel Injector – Cracked Spray Tip, P/N 5229250

Dear Sir:

The enclosed report addresses a reportable notification on an EMD Fuel Injector – Cracked Spray Tip, P/N 5229250.

A copy of the report has been mailed to our affected nuclear customers.

Please sign below, acknowledging receipt of this report, and return a copy to the attention of Document Control at the address above (or, fax to number 252/446-1134) within 10 working days after receipt.

Yours very truly,

ENGINE SYSTEMS, INC.

Susan Woolard
Document Control

Please let us know if ANY of your mailing information changes - name of recipient, name of company/facility, address, etc. Mark the changes on this acknowledgment form and send to us by mail or FAX to the number above.

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RECEIVED: _____

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*IE19
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Report No. **10CFR21-0126**

Rev. 0: **08/22/19**

**10CFR21 REPORTING OF DEFECTS
AND NON-COMPLIANCE**

COMPONENT: EMD Fuel Injector – Cracked Spray Tip
P/N 5229250

SYSTEM: Emergency Diesel Generator

CONCLUSION: Reportable in Accordance with 10CFR21

Prepared By: *Ju Lin*
Engineering Manager

Date: 8/22/19

Reviewed By: *Dan Probst*
Quality Manager

Date: 8/22/19

| REV | DATE | PAGE | DESCRIPTION |
|-----|----------|------|----------------|
| 0 | 08/22/19 | | Initial issue. |

Pursuant to 10 CFR 21.21(d)(4), ESI is presenting the required information as follows:

(i) Name and address of the individual or individuals informing the Commission.

| | |
|------------------------------|------------------------------|
| <i>John Kriesel</i> | <i>Dan Roberts</i> |
| <i>Engineering Manager</i> | <i>Quality Manager</i> |
| <i>Engine Systems Inc.</i> | <i>Engine Systems Inc.</i> |
| <i>175 Freight Rd.</i> | <i>175 Freight Rd.</i> |
| <i>Rocky Mount, NC 27804</i> | <i>Rocky Mount, NC 27804</i> |

(ii) Identification of the basic component supplied within the United States which fails to comply or contains a defect.

EMD Fuel Injector, P/N 5229250

(iii) Identification of the firm supplying the basic component which fails to comply or contains a defect.

Engine Systems Inc. (ESI)

(iv) Nature of the defect or failure to comply and the safety hazard which is created or could be created by such defect or failure to comply.

Fuel injector, P/N 5229250, S/N R2200, was sent to ESI for failure analysis and the spray tip was found to have a through wall crack. Inspections determined the fuel feed holes in the body of the spray tip were incorrectly drilled resulting in one of the holes not properly penetrating the reservoir. It is in this area where the crack initiated and propagated through the full section of the spray tip.

A cracked spray tip would inhibit proper combustion of fuel within the corresponding power cylinder which could affect the load carrying capability of the diesel engine. This could impact the operability of the diesel engine and thereby prevent the emergency diesel generator set from performing its safety related function.

(v) The date on which the information of such defect or failure to comply was obtained.

July 17, 2019

(vi) In the case of a basic component which contains a defect or fails to comply, the number and location of these components in use at, supplied for, being supplied for, or may be supplied for, manufactured, or being manufactured for one or more facilities or activities subject to the regulations in this part.

| Serial Numbers | ESI Sales Order | Customer | Customer P.O. | Qty | C-of-C Date |
|---|------------------------|---|----------------------|------------|--------------------|
| <i>Injector w/ cracked tip R2200</i> | 93870 | <i>Pooled Equipment Inventory Company (end user is Exelon – Nine Mile Pt.)</i> | PG00-1 | 20 | 02/26/02 |
| <i>Remaining suspect injectors from same rebuilt lot R2159 R2145 R847 R2587 R2160 R2179 R2545 R2158 R4244 R2140 R2163 R2217 R2142 R2406 R2219 R2138 R2024 R2178 R2152</i> | | | | | |

The original manufacturer was contacted and stated they have not seen this anomaly nor do they have record of warranty returns due to this discrepancy. Furthermore, based on the age of the tip (repair kit PO date is 2001), if other tips contained this same discrepancy it is highly likely they would have been detected or replaced by now. For these reasons, it is ESI's belief the extent of condition is limited to this single spray tip; however, until proven otherwise the entire batch is considered suspect.

Note that while this injector was refurbished in 2002, it was only subjected to a limited number of engine run hours (approximately 10 hrs) since the rebuild. The reason for this is the injector is part of a pooled equipment inventory system that maintains spare components for use by participating companies.

(vii) The corrective action which has been, is being, or will be taken; the name of the individual or organization responsible for the action; and the length of time that has been or will be taken to complete the action.

For the end user:

- *The immediate action was to remove the injector and replace with a different fuel injector.*
- *Given this injector was 1 of 20 reworked on the same order with the same batch of material, ESI recommends performing an inspection on the remaining 19 injectors. For injectors not yet installed, this should be performed prior to installation. For injectors installed on the engine, this should be performed at the next available maintenance window. In terms of risk associated with a crack developing for an installed injector, ESI believes the risk is low. The incorrectly drilled hole appears to be a single event issue and for remaining injectors installed at the same time as the cracked injector, credit may be taken for accumulated successful run time.*

The injectors should be returned to ESI for disassembly inspection to confirm correct drilling. This will be followed by re-assembly and full functional testing (consisting of re-calibration and 2-hour extended run time testing at 900 rpm). Upon receipt of injectors, ESI will complete this task within 30-days.

For ESI:

- *The injector repair kit (P/N 40084754) that contained the spray tip has been discontinued and is no longer utilized.*
- *ESI has implemented an inspection for all new injectors to verify proper fuel feed hole drilling in the spray tip prior to assembly of the injector.*
- *ESI refurbished an additional set of 20 injectors on the same customer order as the cracked tip injector (total qty of 40 injectors on customer P.O. PG00-1); however, these injectors contain rebuild kits from a different PO and the activity was performed 2 months prior to the cracked tip injector rebuild. ESI has requested this batch of injectors to be removed from storage and returned for disassembly inspection to confirm correct drilling. This will be followed by re-assembly and full functional testing (consisting of re-calibration and 2-hour extended run time testing at 900 rpm). Completion of this activity will provide additional assurance as to the isolated nature of the incorrect drilling. Upon receipt of injectors, ESI will complete this task within 30-days.*

(viii) Any advice related to the potential defect or failure to comply about the facility, activity, or basic component that has been, is being, or will be given to purchasers or licensees.

See Attachment 1 for additional discussion.

ATTACHMENT 1

ADDITIONAL DISCUSSION ON CRACKED SPRAY TIP

The injector, P/N 5229250, was procured new in 1991 and later rebuilt in January 2002 using kit P/N 40084754 (containing spray tip P/N 40084674). The kit was purchased in November 2001. The rebuilt injector was installed and operated in an engine for approximately 5 hours in January 2002. It was then removed from the engine and placed in long term storage. Annually, the stored injectors were bench tested (pop testing, pressure test, rack freeness) and returned to storage to extend their shelf life for an additional year.

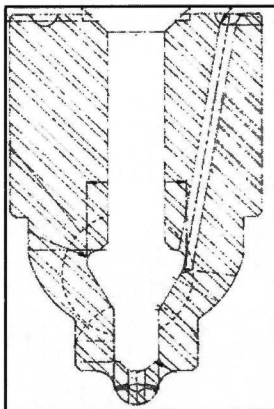
The injector was placed in operational service in December 2018 and failed soon afterwards. The injector failed to chatter, wouldn't build pressure, and leaked at the nozzle. Disassembly inspection revealed a cracked spray tip. Refer to injector assembly, Figure #1.

During normal injector operation, the fuel beneath the plunger is carried to the injector spray nozzle through the check valve and through holes drilled in the spring cage. The fuel is then directed to the internal reservoir machined internal to the nozzle via three drilled passages. These passages intersect the reservoir 120° apart. As the pressure increases in the reservoir during the operation of the plunger, the valve spring lifts from its seat and fuel is emitted from the six holes machined in the tip of the nozzle. As the fuel exits the nozzle, it is finely atomized and creates the sharp chatter sound from the injector.

With the cracked spray nozzle, the pressure is not able to properly build up and atomize the fuel. During testing on the manual injector test stand, fuel leaks through the crack during each manual stroke without developing sufficient pressure in the nozzle to lift the valve spring. It is not known if operation at normal engine speed (15 cycles/second) results in partial atomization of the fuel.

The crack was visible without magnification and extended from the machined outside diameter on one side across the tip and partially down the other side. See Photo #1. It was decided to section the spray tip and inspect the internal machined reservoir.

The section was made to bisect the spray tip through one of the fuel feed holes, as shown below. See Photo #2 for end view of sections.



The sectioned spray tip identified the fuel feed holes were not properly oriented. The axis of the feed holes are supposed to be on the centerline of the body, and tilted 10° off vertical. The as-found holes are not on the body centerline as shown in Photo #3.

The incorrect drilling resulted in one of the holes not properly penetrating the reservoir. A small indication is visible in the left hand section where the reservoir and hole have joined. It is in this area where the crack initiated and propagated through the full section of the spray tip. See Photos #3 through #5.

A visual indication of the hole axis orientation is shown in Photos #6 & #7. In these photos a 0.062" diameter pin gage is inserted in the feed hole that doesn't penetrate the reservoir. The needle is inserted in the center of the tip to provide a reference for the centerline of the body. When properly oriented, in Photo #7 the pin gage and valve needle should appear parallel. The angle between these was measured to be approximately 8°.

FUEL INJECTOR

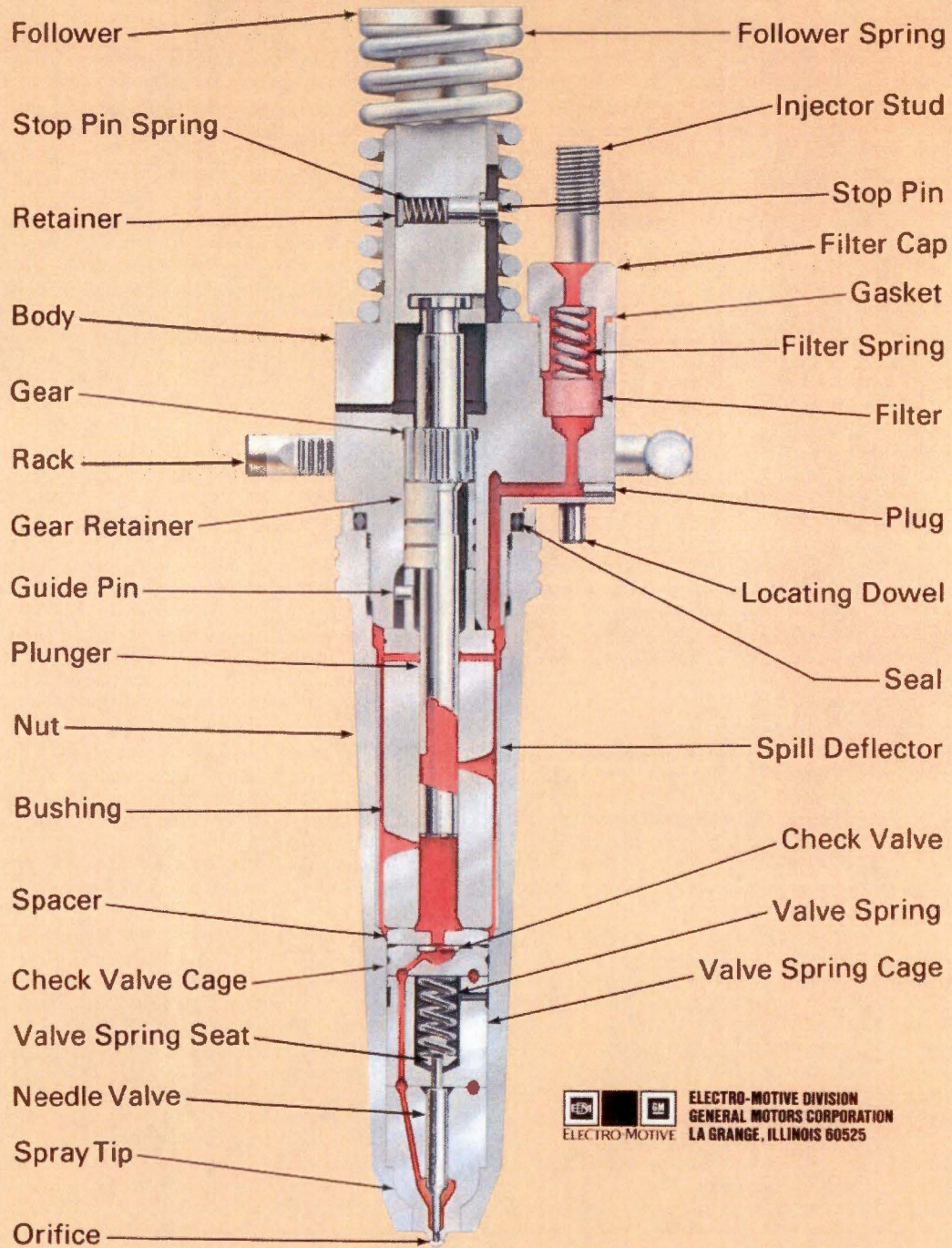
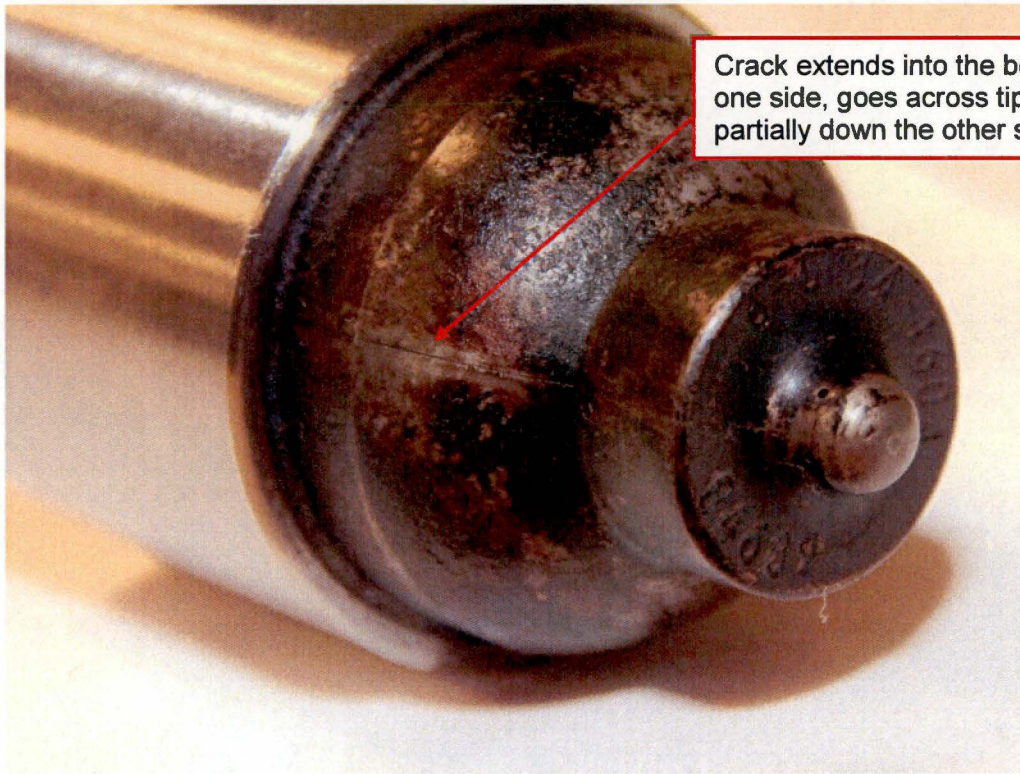


Figure #1
EMD Unit Injector



Crack extends into the body on one side, goes across tip and partially down the other side.

Photo #1
Cracked Injector Spray Tip



Photo #2
Tip sectioned through one feed hole

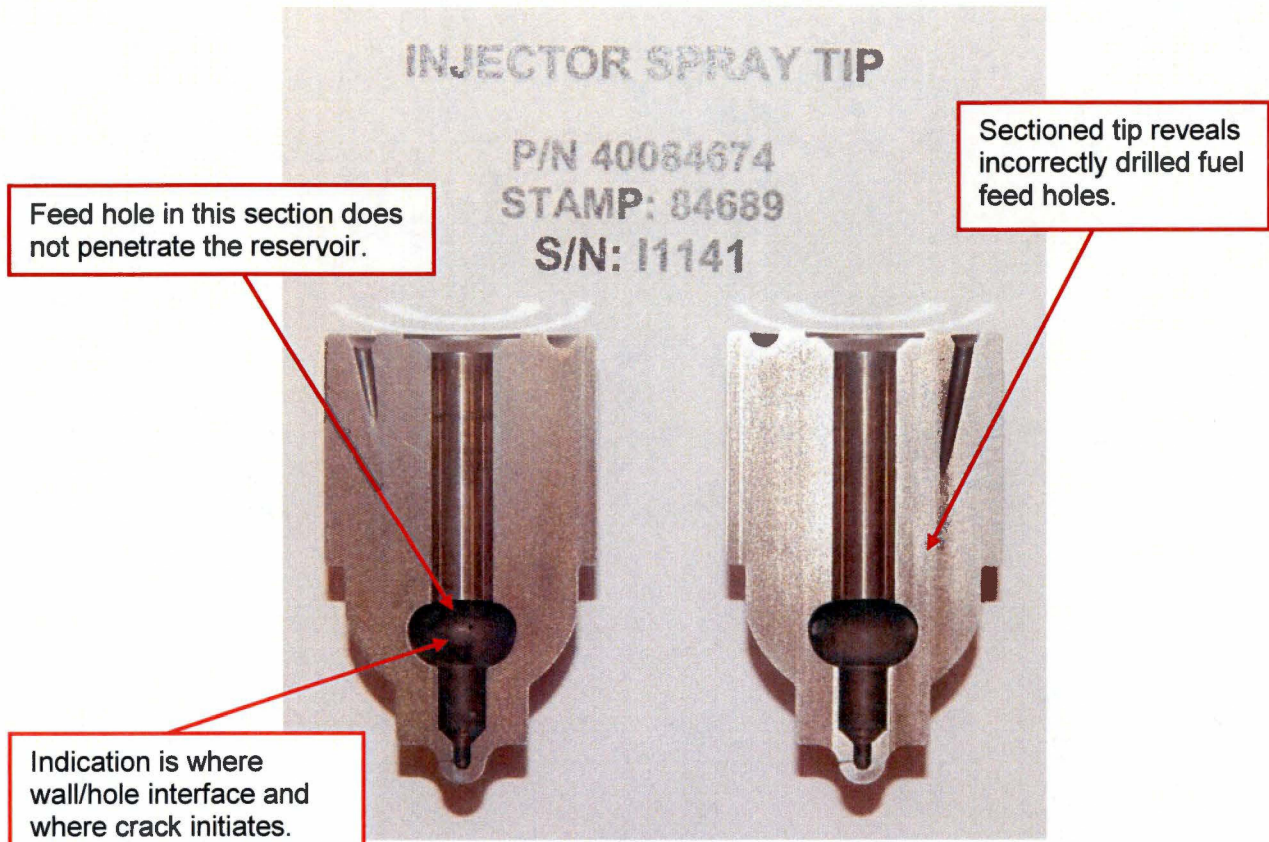


Photo #3
Incorrectly drilled feed holes

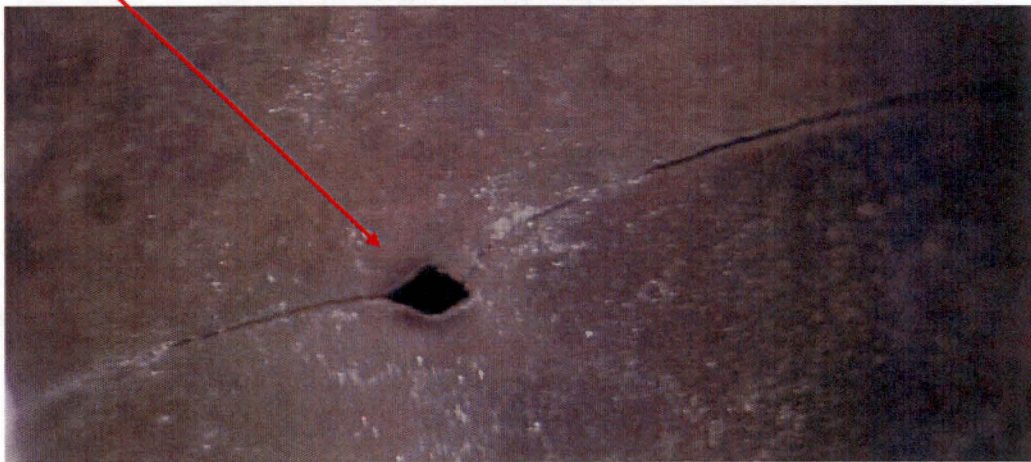


Photo #4
Crack Initiation

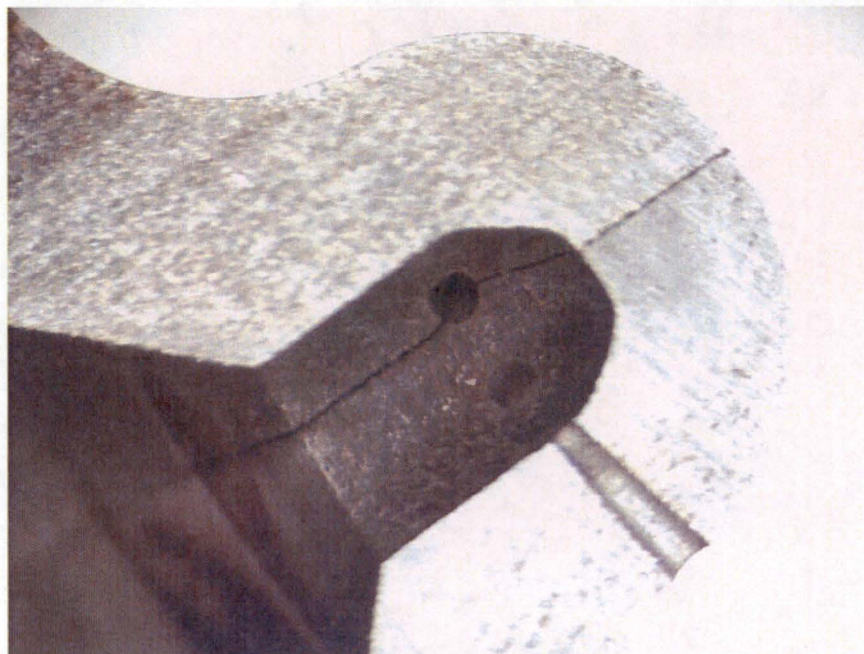


Photo #5
Crack at tip viewed from inside section

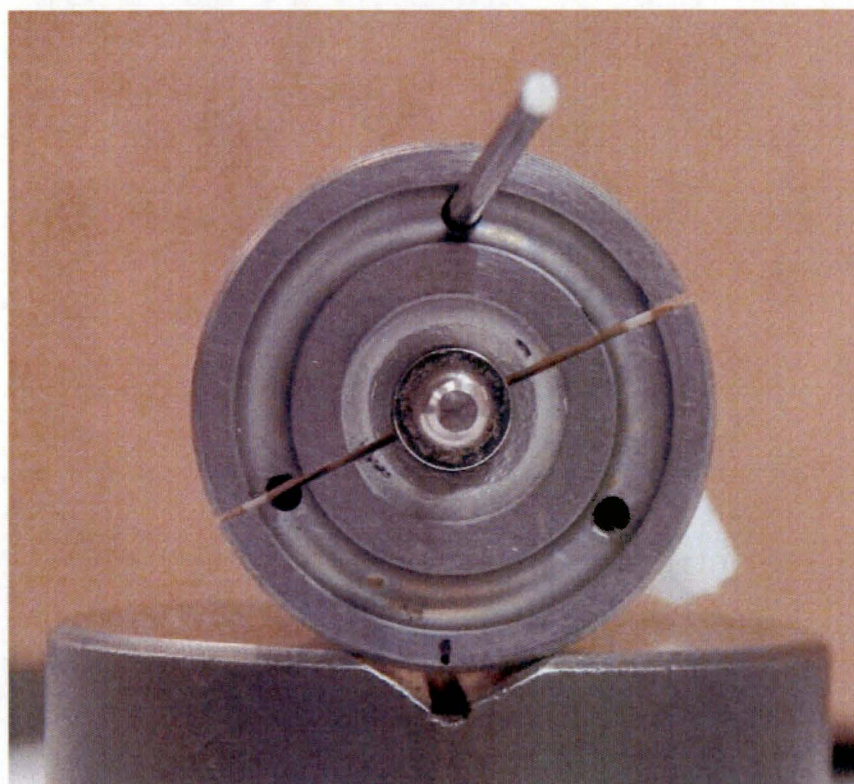


Photo #6
Spray Tip with 0.062" dia pin gage inserted, end view

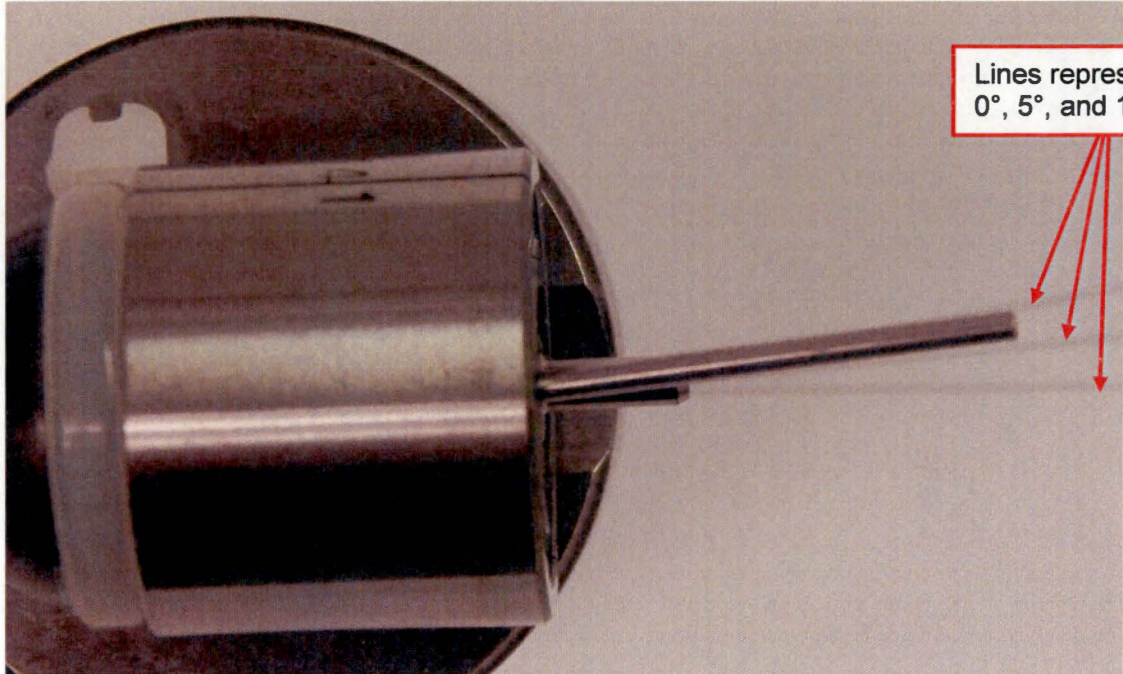


Photo #7

Spray Tip with 0.062" dia pin gage inserted, side view