

STATE-OF-THE-ART CLUSTERING BORESONIC CENTROIDS AND SIZING POTENTIAL FLAWS FOR PREDICTING INSPECTION INTERVALS OF BORED STEAM TURBINE ROTORS

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ABSTRACT

A graphical user interface based in-house program is developed to cluster boresonic indications (centroids) emerging from rotor bore inspection. These centroids are first visualized on various 2-D and 3-D plots with all bore transitions. Any duplicates are deleted. The centroids are clustered as flaws using two methods: a) If the equivalent flat bottom hole (EFBH) size of centroids is supplied by NDE vendor, a spherical clustering approach based on ligament yielding is used, b) If EFBH size is not supplied, the centroids are clustered using ellipsoidal surface criterion. Varying stresses along the axial and radial directions are used. A statistical based fracture toughness value (a material property) is used to calculate the failure probability of each cluster flaw which sums up to existing rotor failure probability for all cluster flaws. Again, the linked up flaws are observed in detail on 2-D and 3-D plots especially those with high stress intensity factor and hence high failure probability. During the observation, boresonic centroids/ cluster flaws can be zoomed in or out, rotated or limited within user specified axial, radial and circumferential windows. A mathematical subroutine in the program determines if the flaw is planar (crack-like) or volumetric and also reduce its size especially if the flaw is oriented at an angle with respect to major or minor axis of the rotor. Based on the orientation, location and planar characteristics, worse flaws can be further downsized manually. For a rotor that requires bore oversizing, centroids at the oversized bored region are virtually deleted and the subject procedure is iterated until an optimal bore size is attained. A safe inspection interval is then recommended for the rotor.

In order to evaluate possible growth of any pre-existing cracks or flaws, cluster flaws arising from boresonic inspections conducted at different time intervals, of same rotor, are directly compared. This can also provide the margin of error with respect to past inspections, if conducted by same NDE vendor or with same type of boresonic equipment/technology. Variability in recorded data may also arise due to advancement in boresonic indication location and detection methodology over the period of time, operator's expertise, quality of equipment used and environmental conditions under which the inspection was performed.

For old rotor forgings (1940's and 1950's) with poor metallurgical properties that may result in large number of boresonic centroids, the program has the capability to cluster even more than 50,000 centroids within a reasonable time frame. Any number of cluster flaws can be individually observed and downsized.

INTRODUCTION

With significant advances in rotor boresonic (ultrasonic examination performed at the rotor bore) technology and equipment lately, any major discontinuity arising from original forging to service induced crack in a bored rotor forging can be detected and recorded with decent extent of reliability. Presently, the instrumentation is sensitive enough to record discontinuities of 0.06 inch depth or even smaller. This also means that more and more flaws will be recorded which may not have been picked up in past inspections. For this purpose, various computer softwares are required to remove false, duplicate or under threshold indications and also to process boresonic data for meaningful conclusions/inspection intervals.

The volumetric type of discontinuities present in a forging (from original heat treatment or ingot consolidation) cannot grow but can be potential sites for crack initiation, depending upon the loading, metallurgical properties and environment at a given location in a forging. Again with the material degradation over the time and effects of fatigue, creep and embrittlement, a crack can initiate and grow. Hence, a growing crack would limit the useful life of a forging. Therefore, condition assessment softwares such as EPRI SAFER PC version 2.2 are used to analyze the boresonic indications and if these indications form close groups or cluster flaws at any location(s) of rotor forging. These cluster flaws are then studied individually in detail and if any of them is crack-like.

The fatigue phenomenon (due to start-stop cycling) is considered to be one of the major cause of crack growth (especially axial-radial type of cracks in bored rotors). Over the years, some of the steam-turbine units have been used as peak cycling units rather than originally designed base loaded units. This increase in start-stops cycling cause higher fatigue crack growth rate, especially for those flaws/cracks which are present in poor material (low fracture toughness) and high load (stress) type of environment.

This paper insight specifically on the recent developments made in the condition assessment software for analyzing bored steam turbine-generator rotors.

BACKGROUND

An indication is detected and recorded by the boresonic inspection. Based on the reference coordinates, the location of the indication can be defined by the cylindrical coordinates in form of axial, radial and circumferential locations. For a rotor, the axial location is defined along its length, the radial being the depth into the forging from either the bore surface or the centerline and circumferential location is theta rotated along its circumference.

During a boresonic inspection, divergent ultrasonic beam technique is used which produce a target motion line. A target motion line (TML) is a series of indications from one reflector as characterized by beam spread, search unit motion and type of reflector. Since these multiple indications from the same reflector (TML) are undesirable, further processing of data can remove TML and record an indication with axial, radial and theta locations together with maximum amplitude. The indication after TML is corrected is then referred as a centroid. The centroids

are then linked up by computer programs to form clusters. The centroids or clusters can be observed on 2-D and 3-D plots. Figure 1 shows a 3-D plot of centroids around the bottle bore.

ELLIPSOIDAL METHOD WITHOUT EFBH

This method is used when the boresonic inspection data is supplied without the equivalent flat bottom hole size (EFBH) of a centroid (EFBH is the equivalent diameter of an indication evaluated based on the comparison of the actual amplitude of an indication to the amplitude of a standard calibrated flat bottom hole size). However, this method is still applicable when EFBH data is supplied since EFBH information is not required by this method.

In this method, each centroid with axial (Z), radial (R) and theta (θ) coordinates is considered to be surrounded by a virtual ellipsoid with a (radial), b (tangential) and c (axial, along rotor major axis) dimensions. A cluster is considered to exist when 2 or more of these ellipsoids touch or intersect one another.

The linkup distance between the ellipsoids is an important variable [1]. The linkup distance is controlled by the boresonic system. The axial scan increment (if not spiral) controls the linkup distance in axial direction. The axial linkup distance cannot be less than axial scanning increment (ASI). Generally, linkup distance = ASI plus 20% ASI. Two ellipsoids touching at an axial distance of 0.30" should have ASI as 0.25" or less. Hence, decreasing ASI is an advantage as axial linkup distance will decrease and hence cluster analysis will be more sensitive due to increased number of clusters. This will however, increase the cost of examination and analysis. Again the circumferential linkup distance and radial linkup distance will depend upon the theta interval at which data are collected.

The distance between two centroids is computed as a selected criterion length (L). The sum of the internal distances between the two ellipsoids along the direction of the distance between the centers (D) is then compared with the selected criterion length (L).

Therefore, 2 centroids are assumed to be a part of the cluster if $D \geq L$.

The basic equation of ellipsoid is:

$$X^2/a^2 + Y^2/b^2 + Z^2/c^2 = 1$$

where [X,Y,Z] are the cartesian coordinates (converted from polar coordinates). The size of the ellipsoid is defined by a, b & c dimensions.

With the help of vector algebra and matrices, the distances described above are evaluated and compared to form a cluster matrix using a computer program. Since the whole process of comparing each and every ellipsoid can be cumbersome and time consuming, various techniques are employed as follows:

- 1) The inspection data received from different vendors (after TML correction) is sorted to a standard format (ufile) into the program as shown in Figure 2. The location of centroids

- 2) along with their amplitudes or EFBH (equivalent flat bottom hole sizes) data are also shown in Figure 2. Any duplicate points are deleted.
- 3) The data in cylindrical coordinates are converted to Cartesian coordinates as Z (axial), X and Y dimensions respectively.
- 4) It is assumed that the major axis of the ellipsoid (c) will always be parallel to the rotor centerline. It is also assumed that every ellipsoid will have same a, b & c dimensions. Therefore, 2 ellipsoids separated by an axial distance greater than 2c cannot touch/overlap. Similarly for the same axial location (Z), 2 ellipsoids separated by a distance greater than 2a cannot touch/overlap if $a \geq b$.
- 5) All the centroids are sorted in ascending order of preference as Z, X and Y respectively.
- 6) The subroutine starts with two groups, one with centroids having starting Z values (z1) and another with centroids upto $z1 + 2c$. Each and every centroid of these groups is compared with each other using ellipsoidal criteria. The clusters formed are stored in a separate cluster matrices using serial numbers. Then second group (from $z1 + 2c$) is compared with third group (upto $z1+2c+2c$) and so on till the end.
- 7) If an ellipsoid in group 1 touch/overlap an ellipsoid in group 2 and same group 2 ellipsoid touch/overlap group 3 ellipsoid, group 1 ellipsoid and group 3 ellipsoid will be the part of same cluster.
- 8) Initially, several cluster matrices are formed. These matrices are compared with each other and those containing common members are united into one. Ex. Cluster matrices A contain centroids # [1, 4, 6], Cluster matrices B contain centroids # [1, 2, 5, 6, 7] and Cluster matrices C contain centroids # [3, 8, 9]. The cluster matrices A & B will then unite as A [1, 2, 4, 5, 6, 7] but matrix C will remain unaffected as it contains no common members to A or B. These will be treated as two separate cluster flaws A & C.
- 9) After all the matrices are resized, each final matrix represents a cluster containing centroids whose ellipsoids touch/overlap with atleast one other ellipsoid within the same cluster. Again, the user can input the minimum number of centroids a cluster should contain to be called as a cluster (atleast two).
- 10) All the computer programs were written in Matlab 7.0 software [2] and later converted to graphical user interface (GUI). Matlab is known commercial software that can handle large matrices efficiently.

SPHERICAL METHOD WITH EFBH

When the EFBH size is supplied by the NDE vendor, the indications can also be clustered together using the spherical method. Since the diameter of each centroid is specified, large centroids can be separated from the small ones, and can be filtered out, if required.

The method assumes that the ligament between two given spheres (of EFBH size) under given load can yield if the spheres are close to each other [3]. Hence, the ligament will no longer support the load and these two spheres will cluster together into one. This is a known method of clustering is deployed by EPRI in its SAFER PC version 2.2 software.

The method thus uses the applied local stress along with the yield stress of the material. Based on these stresses, the method evaluates the increase in the size of each sphere. Again, the sum of

the internal lengths of spheres (D) is compared with the vector distance between the centers of two spheres (L).

Again, 2 spheres are assumed to be a part of the cluster if $D \geq L$.

Some of the techniques mentioned in last section are employed to reduce computational time. The advantage of this method is that actual size of each ultrasonic centroid is used for clustering which could vary. However, most of times, the EFBH sizes are not supplied by the NDE vendor or the boresonic equipment does not support it. Ex. GE boresonic system supplies EFBH for data obtained by its straight radial beam transducer (ultrasonic beam projected straight upwards into the forging, detects volumetric type of discontinuities) but not by angle beam transducers (clockwise and anticlockwise search units, project ultrasonic beam at about 45°-60° into the forging to detect axial-radial type of flaws), which are more important transducers.

FLAW SIZING

The axial length, radial depth and circumferential width of each cluster flaw is computed initially as the difference of maximum and minimum coordinates in the cluster. For Ex. if a cluster contains 3 centroids with Z, R & θ as [101.23, 3.45, 230], [101.44, 3.31, 229] & [101.48, 3.36, 231] respectively, then the size of the flaw defined by axial length of 0.25", radial depth of 0.14" and circumferential width of 2°. A sample of cluster file is shown in Figure 3. Basically, it shows the number of centroids each cluster flaw contains, axial locations and flaw length, radial location and flaw depth, circumferential location and flaw width, stress intensity factor and failure probability (when compared to fracture toughness of material).

Since the depth of a flaw is a critical parameter, the new subroutine divides the cluster flaw axially into sections and then finds the radial range in each section. The maximum of these radial ranges is then considered as the final depth of the flaw. The axial and circumferential ranges remains as initially calculated and only radial range may change. In such a way, any cluster (especially with large number of centroids in axial direction) oriented at an angle to rotor centerline will have the maximum radial depth from a section rather than the range between the maximum and minimum points. This radial depth is more realistic representation of a cluster flaw. Again the division of flaw in axial sections (As) depends upon the axial scanning increment (ASI). Based on the ASI, the user can input and hence control the division. Figure 4 shows the minimum and maximum values of radial depth (from centerline), R (in red) and the revised R values (in blue) of a cluster flaw by 'chopping' the flaw in axial sections. The numeric differences can be observed in Figure 3 where Dr Diff represents the initial depth difference ($R_{max} - R_{min}$) and NDr Diff represents the revised depth difference ($New R_{max} - New R_{min}$) for a cluster flaw.

Further, each of the cluster can be individually observed on 2-D and 3-D plots. During the observation, boresonic centroids/ cluster flaws can be zoomed in or out, rotated or limited within user specified axial, radial and circumferential windows as shown in Figures 5A to 5C. With the help of these plots, the orientation of the flaw with respect to the bore centerline, axial depth and amount of ellipsoidal overlap can be visualized.

For example, an axial-radial type planar crack will have several centroids connected together axially but with small theta range in a cluster. The depth will be smaller than the length. Unlike, a volumetric type of discontinuity will have depth greater or equal to length and may have large theta range in the cluster.

If the depth of the cluster is greater than its length, the cluster flaw is considered volumetric and hence, not serious. On the other hand, if the depth is smaller to the length, then the subroutine computes the normal probability of failure of the flaw (Ex. flaw #30 in Figure 3). For this purpose, a stress file containing stresses in ten radial zones and any number of axial zones of rotor is used. Again, the stresses can be evaluated by classical methods or by finite element stress analysis. The stress in a given direction is considered by the vector sum of all the applied stresses such as mechanical stress, thermal stress or residual stress.

Also, the material fracture toughness with statistically computed coefficient of variance is used. This fracture toughness value can either be obtained from test data or can be theoretically evaluated from other parameters (such as Charpy V-Notch / FATT values, if known). By the principles of fracture mechanics, the stress intensity factor and hence, normal probability of failure is computed for each flaw and then summed up together for all the cluster flaws. The total sum of the failure probabilities then represents the then existing failure probability of the rotor.

BORE OVERSIZING

Once the flaws are sized and analyzed, the serious ones can be separated and can be further downsized by observing the orientation, stresses at given location and material fracture toughness. Again, these flaws can be correlated with the visual, magnetic particle or eddy current inspection data in case the flaws are present close to the bore surface. Otherwise, the NDE vendor can also size the flaws or at least the worst flaws. Since the stresses at the bore surface are the highest, the flaws close to the bore surface are typically of major concern. Therefore, if large and serious flaws are present at or close to the bore surface which seriously limits future operation of the rotor (high failure probability), they have to be removed by oversizing the bore.

With the increase in the size of the bore, the stresses at the bore surface (and overall) increase since less material supports same load. Moreover, any buried flaws which maybe large originally but not critical due to relatively lower stresses radially away from the bore surface, can become serious surface flaws due to bore oversizing.

The bore oversizing may be increasing the size of the bore all along the length, only at the partial length of the rotor (which contains large flaw density) known as bottle bore or both. Proper bore diameter should be selected. It may not be necessary to remove all the indications close to the bore surface at the expense of large bore diameter but the critical ones, which when removed, extend the future operation of the rotor to a reasonable interval.

For this purpose, the computer program inputs the oversized bore diameter after a run is made with original bore diameter. The centroids at the oversized bored region are virtually deleted and the subject procedure can be iterated until an optimal bore size is attained. The optimal bore size

diameter(s) should meet all the design criteria and the remaining centroids (if any) would cluster together resulting in low failure probability of the rotor.

CLUSTER DATA COMPARISON

In order to evaluate possible growth of any pre-existing cracks or flaws, cluster flaws arising from boresonic inspections conducted at different time intervals, of same rotor, are directly compared. The program inputs a reference cluster file and the new cluster file to be compared. The user can input the margin of error for the axial, radial and circumferential locations. Also the axial, radial and circumferential margin of errors can be a user input. The input can be adjusted according to the observation both at the reference and new cluster flaw file. The following scenarios are considered

- 1) The new cluster is much larger in size than the reference cluster such that the reference cluster is a subset of the new cluster.
- 2) Any of the axial, radial or circumferential locations of the new cluster overlap with the dimensions of the reference cluster either from start or end (with or without margin of error).

The overlapped clusters from the reference to the new file are then compared as shown in Figure 6. The '0' represents the reference file and '1' represents the cluster file to be compared. The user inputs the margin of error for axial, radial and circumferential locations and the flaws are compared if any of the two scenarios's mentioned above arise.

CONCLUSIONS

The boresonic inspection data are analyzed by the condition assessment software which sorts the data into standard format and deletes any duplicate centroids. A clustering subroutine links up centroids to form cluster flaws, each with axial length, radial depth and circumferential width. The centroids/cluster flaws can be observed visually on 2-D and 3-D plots. By the principles of fracture mechanics (using the applied stresses and material fracture toughness), the failure probability of each flaw is evaluated which when summed up for all the flaws, is considered to be the total probability of failure of the rotor. Hence an idea about the then existing condition of the rotor is mathematically obtained. The bore can be oversized if serious surface or near surface flaws exist. The computer program can be iterated for an optimal bore size.

It should be noted that the aforementioned analysis only evaluates the condition of the rotor. The analysis is not sufficient to recommend an inspection interval of the rotor. For inspection interval recommendation, a crack growth analysis is performed on either the worst flaw obtained from cluster analysis or on a default bore surface flaw. This is done using a separate in-house crack growth program.

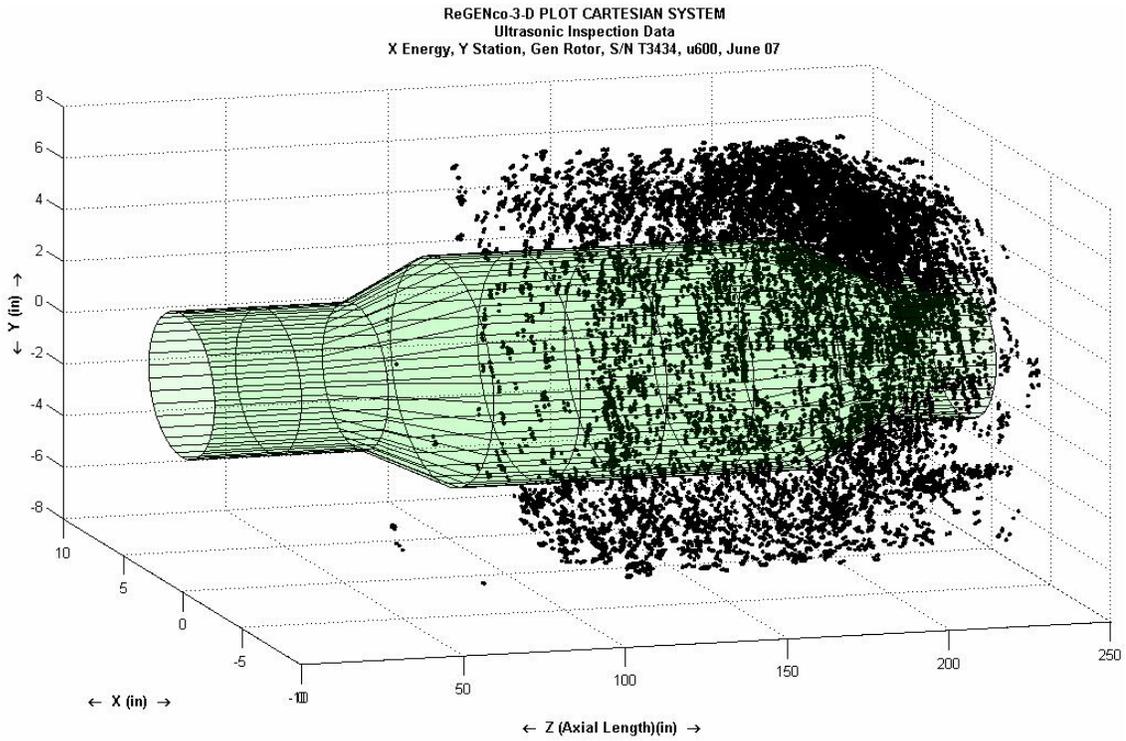
ACKNOWLEDGEMENT

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REFERENCES

1. D.R. McCann, J. Zhang, H.M. Snapp and H.R. Jhansale, "Formulating Potential Flaws from Boresonic Data," Proceedings in EPRI Computer-Assisted Technologies for NDE and Plant Monitoring Workshop, Philadelphia PA, Aug. 10-13, 1992.
2. Matlab 7.0 software, www.mathworks.com
3. Ammirato.F.V et. al, "Life Assessment Methodology for Turbo generator Rotors", Vol 2: SAFER Code Engineering Tutorial, EPRI Research Projects 2481-3, 2785-1, March 1988

Figure 1
Sample 3-D plot of UT centroids around a bottle bored rotor



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August 13-17, 2007, Phoenix, Arizona

Figure 2
Different file formats converted to one standard file format (ufile) used by the program

X Energy, Y Station 10, LPDF Rotor, S/N TB38788, u268, March 07
Turbine End 0 Deg at #1 Balance Hole

Bore Diameter = 6.208 inches from 0.00 to 170.00 inches

***Number of Data Points = 2390

***Number of Deleted (Duplicate/Rebore) Points = 4

***Remaining Number of Data Points = 2386

***Maximum Amp/EFBH =251.0000 Minimum Amp/EFBH =51.0000

Ind/ Group	Axial Pos	Radial Bore	Theta Pos	Amp/ EFBH	Radial Centerline
2	26.330	1.760	149.420	66.000	4.864
2	26.330	1.790	148.850	74.000	4.894
2	26.330	1.830	148.270	70.000	4.934
2	26.330	1.850	147.700	57.000	4.954
31	27.450	0.630	228.990	71.000	3.734
31	27.450	0.660	228.990	137.000	3.764
31	27.450	0.690	228.990	152.000	3.794
31	27.450	0.710	228.420	137.000	3.814
47	28.450	3.680	151.710	51.000	6.784
47	28.450	3.700	151.140	89.000	6.804
47	28.450	3.740	150.560	81.000	6.844
47	28.700	3.690	151.710	63.000	6.794
140	43.950	1.410	209.530	51.000	4.514
140	43.950	1.440	209.530	89.000	4.544
140	43.950	1.460	208.960	104.000	4.564
140	43.950	1.500	208.960	111.000	4.604
140	43.950	1.540	208.380	60.000	4.644
177	50.950	1.760	151.710	70.000	4.864
177	50.950	1.790	151.140	78.000	4.894
177	50.950	1.830	150.560	76.000	4.934
177	50.950	1.850	149.990	66.000	4.954

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August 13-17, 2007, Phoenix, Arizona

Figure 3
Sample output file containing clustering data and failure probabilities

X Energy, Y Station #4, LPDF Rotor, S/N TB38788, u268, March 07
Turbine End 0 Deg at #1 Balance Hole

Bore Diameter = 6.208 inches from 0.00 to 170.00 inches

***Ellipsoidal Parameters: a = 0.1000 b = 0.1000 c = 0.1500
***Number of Data Points = 2386
***NDE Search Unit Type = Circumferential

***Axial Range Processed: 0.00 - 170.00 inches
***Axial Increment for Cluster Radial Depth Resizing = 0.10
***Material Fracture Toughness (KIC) = 40.00 ksi-sqrt-in
***Coefficient of Variation on KIC = 0.10
***Coefficient of Variation on Stress Intensity (KI) = 0.12

TOTAL PROBABILITY OF FAILURE = 1.41e-001%

----- Location from Reference Points -----										
Cluster No.	# Ind	Axial, in.		Radial, in.			Circum, Deg.		Max(KI) ksi-sqrt-in	P.F %
		X Start	Dx Diff	Rg Start	Dr Diff	NDr Ndiff	Theta Start	Dtheta Diff		
1	4	26.33	0.00	1.76	0.09	0.00	147.70	1.72	0.00	0
2	4	27.45	0.00	0.63	0.08	0.00	228.42	0.57	0.00	0
3	4	28.45	0.25	3.68	0.06	0.06	150.56	1.15	9.48	1e-011
4	5	43.95	0.00	1.41	0.13	0.00	208.38	1.15	0.00	0
5	4	50.95	0.00	1.76	0.09	0.00	149.99	1.72	0.00	0
6	4	55.70	0.00	1.30	0.08	0.00	120.79	1.15	0.00	0
7	4	57.33	0.00	1.93	0.10	0.00	60.11	1.15	0.00	0
8	7	58.70	0.25	2.97	0.07	0.07	152.28	1.15	10.45	9e-011
9	4	58.83	0.00	2.97	0.08	0.00	159.15	1.15	0.00	0
10	8	60.45	0.25	0.80	0.13	0.09	122.51	2.86	14.46	2e-007
11	9	60.58	0.25	0.75	0.25	0.14	132.24	4.01	16.18	4e-006
12	8	60.70	0.00	0.84	0.15	0.00	304.56	1.72	0.00	0
13	9	60.95	0.13	0.80	0.11	0.11	143.12	3.44	12.49	6e-009
14	4	60.95	0.00	0.66	0.34	0.00	137.97	1.14	0.00	0
15	3	60.95	0.00	0.68	0.05	0.00	124.80	0.00	0.00	0
16	4	60.95	0.00	0.75	0.05	0.00	114.50	0.57	0.00	0
17	7	61.45	0.25	0.68	0.11	0.08	130.53	1.71	14.26	2e-007
18	5	61.95	0.00	0.59	0.11	0.00	119.08	0.57	0.00	0
19	3	63.20	0.00	1.23	0.07	0.00	64.69	0.57	0.00	0
20	4	63.33	0.00	1.46	0.09	0.00	64.69	1.15	0.00	0
21	3	63.45	0.00	1.44	0.06	0.00	58.39	0.58	0.00	0
22	3	63.70	0.00	1.33	0.07	0.00	55.53	0.57	0.00	0
23	4	63.70	0.00	2.28	0.05	0.00	72.13	0.58	0.00	0
24	4	64.57	0.00	1.40	0.09	0.00	47.52	1.14	0.00	0
25	4	64.70	0.00	0.65	0.04	0.00	174.61	0.57	0.00	0
26	4	65.20	0.00	1.11	0.09	0.00	60.68	1.15	0.00	0
27	5	65.45	0.00	0.51	0.07	0.00	127.66	0.58	0.00	0
28	3	65.70	0.25	0.36	0.04	0.04	129.38	0.57	11.68	1e-009
29	6	66.95	0.00	0.76	0.10	0.00	335.48	1.14	0.00	0
30	17	67.07	0.50	0.38	0.28	0.20	154.00	2.86	23.31	0.03
31	6	67.20	0.25	0.54	0.07	0.07	146.56	1.14	14.09	1e-007

Figure 4
 Cluster flaw divided into sections for revised radial depth (axial – radial view)

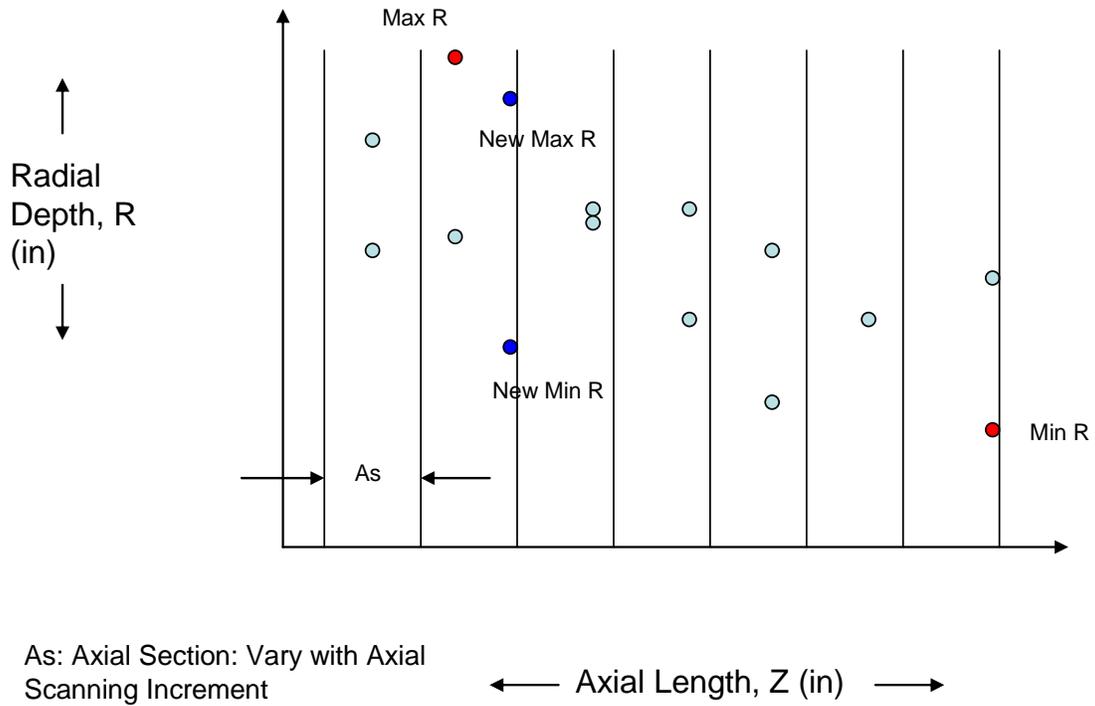


Figure 5A
View of cluster flaw #87 (linked up using ellipsoids) close to the bore surface

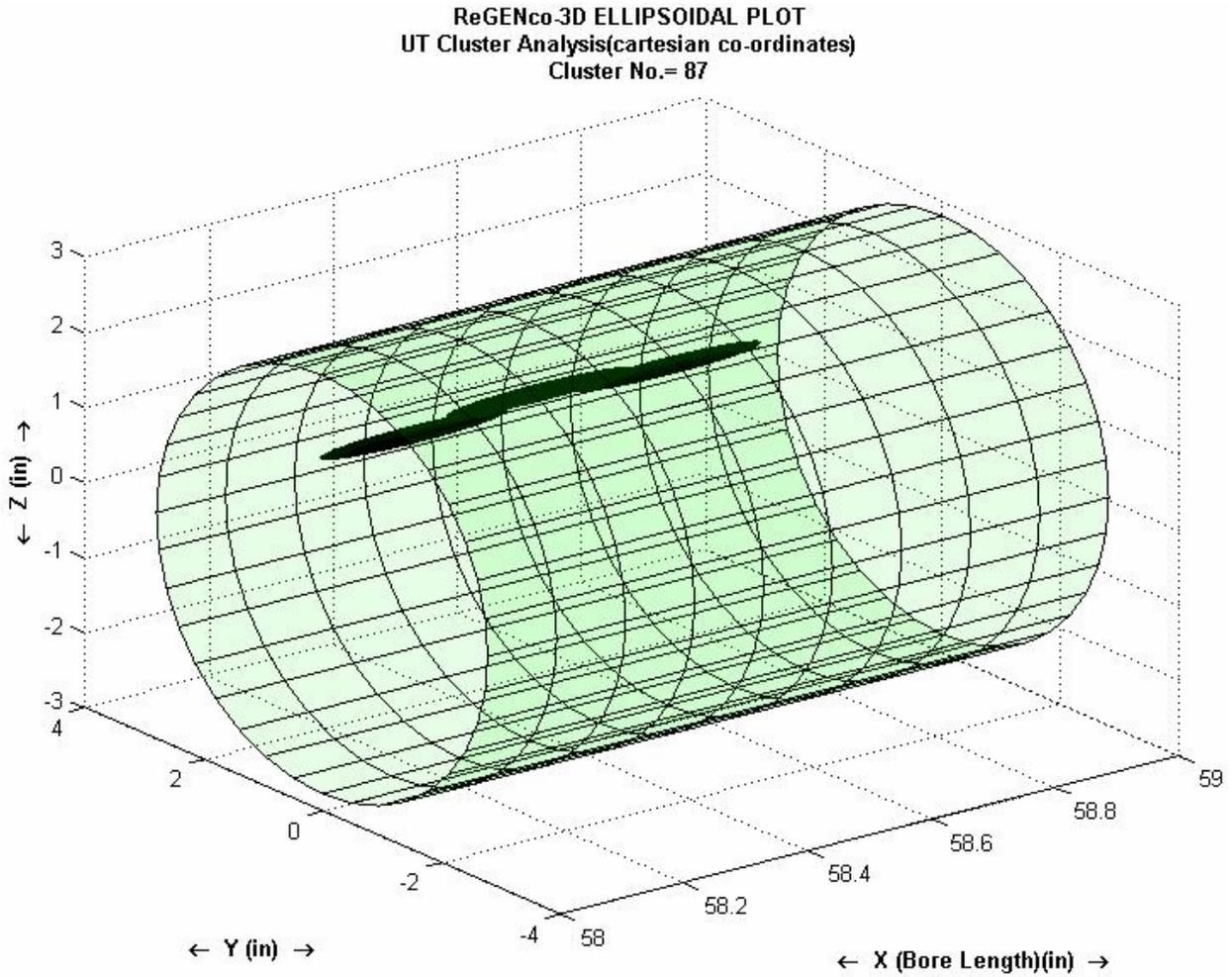


Figure 5B
Close up view of cluster flaw #87 (linked up using ellipsoids) close to the bore surface

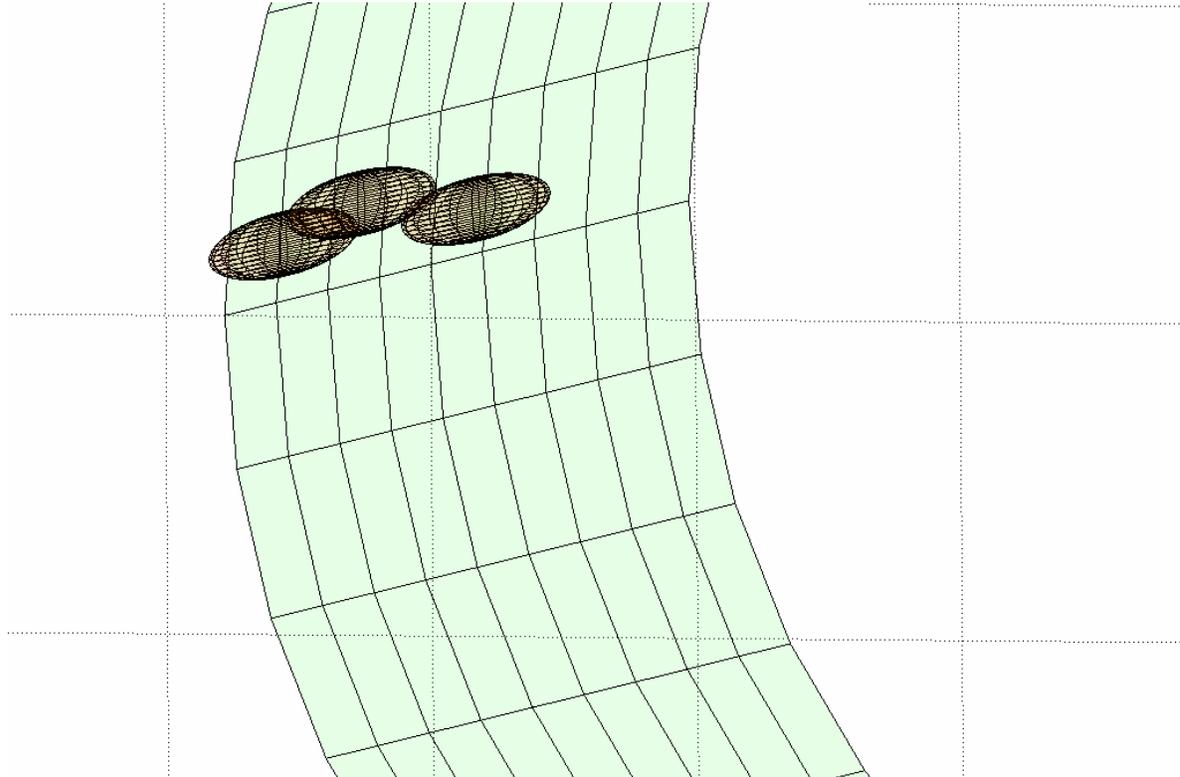
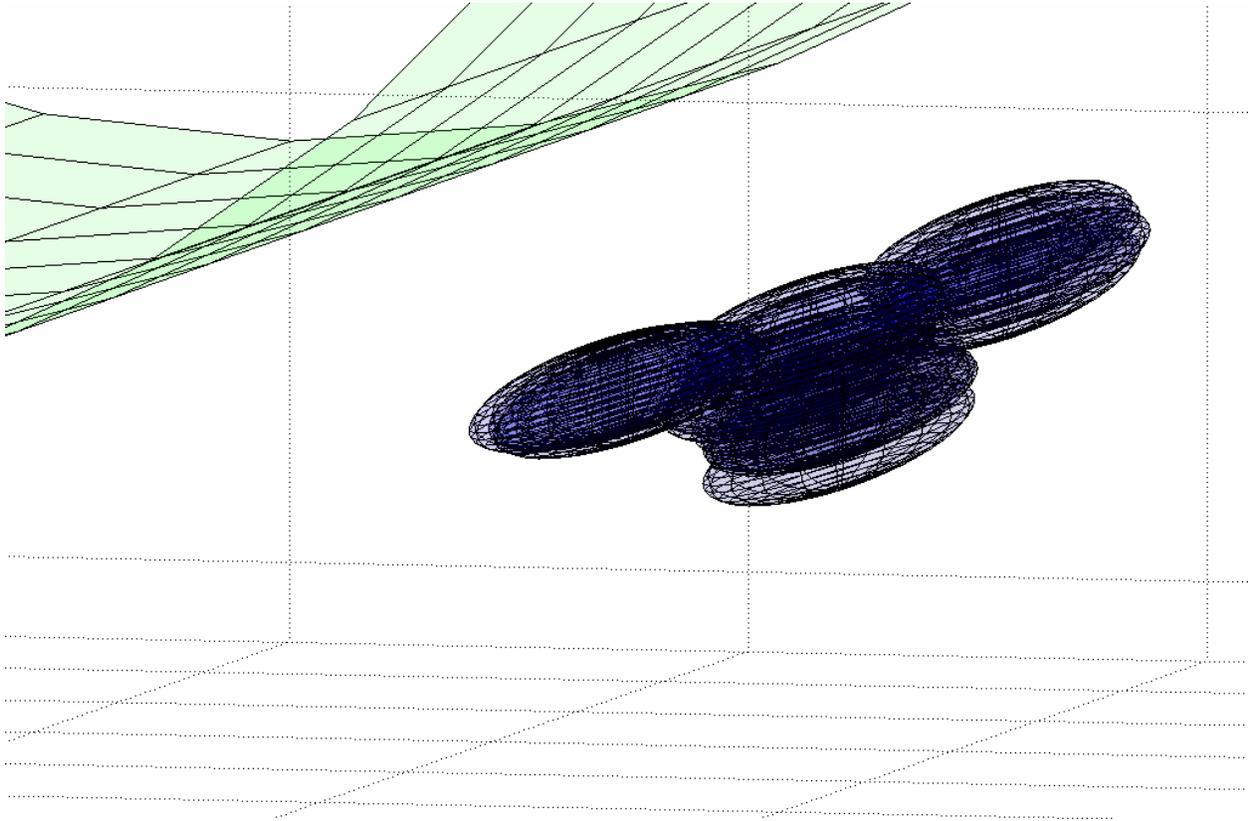


Figure 5C
Close up view of a separate cluster flaw close to the bore surface



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Figure 6
Cluster Data Comparison between two UT cluster files

X Energy, Y Station #3, Cluster files comparison

***Reference Cluster UT File = C:\Documents and Settings\guptav\Desktop\Reference.txt

***Cluster UT File for Comparison = C:\Documents and Settings\guptav\Desktop\New_UT.txt

***Reference Cluster File Below = 0

***Cluster UT File for Comparison = 1

----- Location from Reference Points -----

File No	Cluster No	Axial, in.		Radial, in.			Circum, Deg.		Max(KI) ksi-sqrt-in	P.F %
		X Start	Dx Diff	Rg Start	Dr Diff	Ndr Ndiff	Theta Start	Dtheta Diff		
0	5	107.25	0.50	4.40	0.04	0.03	187.55	0.62	4.69	1e-016
1	5	107.25	0.52	4.38	0.05	0.03	187.48	0.66	4.87	1e-016
0	25	116.63	0.87	4.33	0.18	0.00	247.18	0.89	0.00	0
1	6	116.65	0.84	4.33	0.16	0.00	247.23	0.89	0.00	0
0	26	116.63	0.25	3.72	0.02	0.02	260.33	0.56	5.67	1e-015
1	7	116.65	0.27	3.74	0.05	0.02	260.45	0.56	5.67	1e-015
0	31	116.75	0.25	4.95	0.04	0.04	207.66	1.09	7.61	1e-013
1	12	116.85	0.26	4.96	0.05	0.04	207.55	1.09	7.61	1e-013
