UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

In the Matter of:

AmerGen Energy Company, LLC

(License Renewal for Oyster Creek Nuclear Generating Station)

Docket No. 50-219

AFFIDAVIT OF PETER TAMBURRO

Lacey Township)
)
State of New Jersey)

Peter Tamburro, being duly sworn, states as follows:

INTRODUCTION

1. This Affidavit is submitted to support AmerGen Energy Company, LLC's Motion for Summary Disposition on the contention filed by environmental and citizen groups ("Citizens") opposed to the renewal of the Oyster Creek Nuclear Generating Station ("OCNGS") operating license, and admitted by the Licensing Board on October 10, 2006.

2. The contention, as admitted by the Licensing Board states: "AmerGen's scheduled [ultrasonic testing ("UT")] monitoring frequency in the sand bed region is insufficient to maintain an adequate safety margin." The purpose of my

Affidavit is to address Citizens' allegations regarding the frequency of AmerGen's UT measurements.

3. It is my expert opinion that these allegations have no technical merit because they are based on a misinterpretation of the governing thickness criteria, calculation errors, and speculation about future conditions.

4. It is also my opinion that the frequency of UT of the sand bed region of the drywell shell reflected in AmerGen's existing commitments to the NRC is sufficient to provide reasonable assurance that the applicable thickness acceptance criteria will be met, that an adequate safety margin will be maintained during the period of extended operation under a renewed license, and that the drywell will continue to serve its intended functions.

EDUCATION AND EXPERIENCE

5. I received my B.S. degree in Chemical Engineering from Clarkson University, Potsdam, New York, in 1980. I received my M.S. in Computer Science from Fairleigh Dickinson University, Teaneck, New Jersey, in 1986. I first registered as a Professional Engineer in the State of New Jersey around 1986.

6. I currently am employed as Senior Mechanical Engineer in the Engineering Department at the Oyster Creek Nuclear Generation Station. My current responsibilities include:

- Implementing the above- and below-ground piping monitoring program to ensure piping is capable of performing its intended function. This includes maintaining operating history, risk-ranking plant piping systems, establishing inspection scope and criteria, analyzing inspection results, sponsoring modification and replacement based on inspection results, and overseeing the design and installation of new piping systems. My responsibilities also include the temporary and permanent repair of piping leaks at OCNGS.

- Implementing the OCNGS Drywell Vessel Monitoring Program. This program ensures that the Drywell Vessel (a.k.a. "shell") is inspected consistent with current regulatory commitments. This includes setting scope for future inspections and analysis of inspection results.

7. My past responsibilities included designing and implementing modifications at OCNGS. This included new below- and above-ground piping from 1992 to 2006, and engineering oversight and implementation of all Security Upgrades at the plant from 1998 to 2006.

8. I am very familiar with the historical corrosion of the OCNGS drywell shell. My involvement began in 1988 when I took over the responsibility for "10 CFR 50.59" Evaluation of the issue. This included comparing the design requirements of the shell with the inspection results. This also included setting the outage-related inspection scope, and reporting to the NRC throughout that time period on the results of those inspections.

9. Since 1996, I have been responsible for ensuring upper drywell inspections are performed every other outage. I have also analyzed those inspection results.

10. With respect to license renewal, I have provided historical perspective on drywell corrosion, corrective actions, and inspection. I reviewed and commented on the drywell-related portions of the OCNGS License Renewal Application ("LRA") submitted to the NRC on July 22, 2005, and the LRA supplement submitted to the NRC on December 3, 2006.

11. I supported the NRC license renewal audits and inspections in 2006 as the lead engineer responsible for drywell–related inspections. I supported the response to the NRC Staff's requests for additional information.

12. I assisted in developing the inspection scope for the October 2006 refueling outage, and I analyzed all inspection results.

13. I also participated, as a site engineer knowledgeable about drywell issues, in meetings with the Advisory Committee on Reactor Safeguards (ACRS) on October 3, 2006, January 18, 2007 and February 1, 2007.

<u>OPINIONS OF PETER TAMBURRO</u>

I. Citizens' Allegation of 0.026" Remaining Margin Is Technically Unsupportable

14. I understand that Citizens have asserted that the drywell shell in the sand bed region is 0.026" or less away from exceeding the acceptance criteria for buckling developed by GE Nuclear in the early 1990s. As I explain below, this assertion is based on a misinterpretation of the 0.536" local area average thickness criterion.

15. By way of background, the acceptance criteria for the drywell shell in the Oyster Creek sand bed region are the minimum thicknesses required for the drywell to perform its intended functions. GE Nuclear analyses established these criteria in 1991 and 1992, and they form part of the Oyster Creek current licensing basis.

16. Before the sand was removed from the sand bed region, GE Nuclear performed an engineering analysis of the drywell shell to determine whether historical corrosion prevented the drywell from performing its intended functions. GE Nuclear conducted this analysis in 1991, based on ASME Code requirements, to establish the minimum

required general thickness, with the sand removed, for both pressure and buckling stresses.

17. The results of GE Nuclear's analysis show that the minimum required thickness in the sand bed region is controlled by buckling. By "controlled", I mean that for the analyses performed to model design conditions that might lead to structural degradation, the analysis for buckling showed the least margin. Moreover, a general thickness of 0.736" will satisfy ASME Code requirements with a safety factor of 2.0 against buckling for the controlling operating load combination (*i.e.*, during refueling), and 1.67 safety factor for the accident flooding load combination (*i.e.*, during operations).

18. At that time, a "very local" area thickness of 0.490", not to exceed 2.5 inches in diameter, was also identified. This "very local" thickness criterion is relevant to Citizens' argument about pinholes or holidays, which I discuss in paragraphs 42 and 43, below. However, it is not pertinent to Citizens' argument about 0.026" remaining margin, as I discuss below.

19. In 1992, GE Nuclear performed a series of sensitivity analyses on the original 0.736" criterion. These analyses sequentially evaluated locally-thinned areas using one square foot areas of 0.636" and 0.536", each with a transition to the surrounding shell at a uniform thickness of 0.736". Since Dr. Hausler only references the 0.536" analysis, I will discuss only that analysis.

20. Thus, there are two criteria relevant to Citizens' argument. The first criterion is a *general* average thickness of 0.736". An area of average thickness less than 0.736" remains adequate if it meets the second criterion, which is the 0.536" *local area* average thickness, and other factors such as location, configuration, etc. This local

area criterion includes a one-foot *transition area* to 0.736" on all four sides of the 0.536" area, such that the total allowable contiguous area with thickness below 0.736 is *nine square feet*. This is clearly shown on Figure 1 which I created, and which is based on the GE Nuclear report that was attached to the AmerGen submittal to the ACRS on December 8, 2006, as Reference 22.

21. Dr. Hausler interprets the *local area* criterion as being exceeded if the area thinner than 0.736" is greater than one square foot. He states in his June 23, 2006, memorandum that an area "approximately 1.6 square feet" thinner than 0.736" would be "well beyond the current acceptance criterion." This statement can only be based on a misunderstanding of the local area thickness criterion, which allows for nine square feet.

22. Dr. Hausler's misunderstanding seems to stem from his belief that the local area acceptance criterion is configured with an abrupt step-change (like a cliff) on all sides of the one square foot area that averages 0.536", such that the thickness increases to 0.736" with no transition. See Figure 2.

23. Thus, even if an area of approximately 1.6 square feet thinner than 0.736" existed, the local area acceptance criterion still would not be exceeded because that criterion allows for an area thinner than 0.736" of nine square feet.

24. The actual bounding general average thickness in the sand bed region is 0.800" located in Bay 19, which leaves a margin of 0.064" when compared to the 0.736" general area thickness criterion, not 0.026". All the other bays have greater margin, ranging from 0.074" in Bay 17, to 0.439" in Bay 3. The thinnest local measurement identified by Dr. Hausler was 0.618" located in Bay 13. This leaves a margin of 0.082" when compared to the 0.536" local area thickness criterion.

25. Citizens' assertion that the margin above the acceptance criteria is as low as 0.026", therefore, is not supported by the data.

26. The entirety of Dr. Hausler's argument about the 0.026" of metal thickness can be found on page 7 of his June 23, 2006 memorandum. I will now walk through Dr. Hausler's argument and demonstrate that in addition to misinterpreting the local area acceptance criterion as one square foot, his calculations also are wrong. In order to argue that this criterion will be exceeded in the future, he takes a thin point in Bay 13, and makes an assumption that future corrosion will increase the area around this point such that the area will be larger than one square foot. In other words, he speculates that corrosion—which cannot occur while the epoxy coating is intact—will make the thinned area wider.

27. Dr. Hausler bases his conclusion about 0.026" on the UT data collected from single measurement points on the exterior of the drywell shell in the sand bed region in Bay 13 in 1992.

28. In general, the drywell shell in the sand bed region of Bay 13, prior to 1992, experienced a significant amount of corrosion from the presence of wetted sand. In that bay, the corrosion caused the formation of indentations in a pattern visually similar to the surface of a golf ball. In 1992, before the exterior drywell shell was coated with epoxy, UT measurements showed that the thinnest of these indentations averaged approximately 0.800" in thickness.

29. In 1992, Bay 13 had nine, locally-thin areas less than 0.736". By "locally-thin", I mean the area was less than 2.5" in diameter. The thinnest of these locally thin areas is referred to as "point 7" which had the single thinnest reading of 0.618". Around

this point, the evaluation of the data from 1992 found a larger 6" by 6" square area that averaged at least 0.677" thick.

30. On page 7 of his June 23, 2006 memorandum, Dr. Hausler states that the total area less than 0.736" at "point 7", referring to the area which averages 0.677", is 0.3 square feet. Although the 1992 Oyster Creek reports describe this area as a 6" by 6" square area, Dr. Hausler elects to convert this area into a circular area. The corresponding radius of the circular area, which is 0.3 feet square, is 3.7 inches. I have created Figure 2 to show a profile representing these measurements.

31. Dr. Hausler's next statement is an assumption that is not supported by the data. Dr. Hausler states on page 7 of his June 23, 2006 memorandum that "this area is very sensitive to corrosion because in a length of around 5 inches, the thickness changed from around 0.736 inches to 0.800 inches. Assuming the edge of the hole is a straight line, this means that a change of 0.064 inches in depth occurs over about 5 inches in length." Dr. Hausler assumes that the transition from the thinner area less than 0.736" to areas that are 0.800" or thicker is 5" long (radially). As I said, this assumption is not supported by the data. However, if you construct a model of a hypothetical indentation as described in this unsupported assumption using the 5" transition zone and the corresponding inner radius of the 3.7", the total radius of the model is 8.7" or 17.4" in diameter. Figure 2 also shows this configuration.

32. Dr. Hausler continues with his unsupported assumptions. He concludes that "[t]hus, for the radius of the thin area to change by two inches, the depth would have to change by only 0.026"." The statement that the radius would change 2" can only be an assumption because such a change could only occur through corrosion, and corrosion on the exterior of the drywell shell in the sand bed region has been arrested.

Regardless, by expanding the radius of the indentation by 2", the diameter of the indentation would increase by 4", for a total diameter of 21.7" (this is larger than Dr. Haulser's memo which mentions 17.4" diameter). I have created Figure 3 to show the increase of the radius of the hypothetical indentation by 2".

33. Dr. Hausler then mistakenly concludes that if the 2" radius expansion occurred, then "the total area below 0.736 inches would be approximately 1.6 square feet, well beyond the current acceptance criterion." This conclusion is misleading for a number of reasons.

34. First, this conclusion is proved false by Dr. Hausler's own model. The radius of the expanded area less than 0.736" (shown on Figure 4) is 5.7". Simply calculating the area of a 5.7" radius circle results in 0.709 square feet. This value is significantly less than the 1.6 square foot value that Dr. Hausler offers.

35. Second, Dr. Hausler underestimates how much metal needs to corrode to meet his (incorrect) definition of the local area acceptance criterion. The radius of a 1.6 square foot circle is approximately 8.6". As I explain in ¶31 above, Dr. Hausler uses 8.7" for this value rather than 8.6". See Figure 2. In my opinion, by arriving at his conclusion that a 1.6 square feet area is less than 0.736", Dr. Hausler has made another assumption that the entire original 17.4" diameter indentation is less than 0.736". This assumption would require an additional section of material, 0.033" deep to simply disappear (see Figure 5). Assuming this metal disappeared through corrosion, this corrosion would be in addition to the 0.026" of corrosion that Dr. Hausler hypothesizes. I have created Figure 5 to show the material that would need to disappear (see area designated as "Second Assumed Material Loss").

36. Finally, as I state above, Dr. Hausler then misinterprets the local area acceptance criterion by assuming that an area of one square foot that is thinner than 0.736" exceeds that criterion. He is wrong and I have created Figure 6 to show how the additional corrosion that Dr. Hausler postulates would not exceed the local area thickness criterion. In Figure 6, I have reproduced the acceptance criteria profile from Figure 1, and overlaid Dr. Hausler's assumed contour from Figure 5. The new Figure clearly shows that the acceptance criterion is not exceeded.

II. A Future 0.017" Annual Corrosion Rate Is Also Technically Unsupportable

37. Citizens next argue that corrosion rates around 0.017" per year have been observed. Corrosion rates in the range of .017" per year were observed in the sand bed region prior to 1992. Those rates were developed based upon UT data gathered between 1987 and 1992.

38. If Citizens are suggesting that a corrosion rate of 0.017" per year continued to occur after removal of the sand in 1992, or could occur in the future, they are incorrect for numerous reasons.

39. First, such an allegation ignores corrective actions implemented to date. Much has happened to prevent corrosion from continuing in the sand bed region of the drywell shell. The source of water—the flooded reactor cavity liner during refueling outages—has been identified and controlled. No water is expected to reach the sand bed region when strippable coating is applied to the reactor cavity during refueling outages. Even if some water did reach the sand bed region during refueling outages, the sand has been removed so there is no media to physically hold the water against the drywell shell's exterior. And the historic corrosion occurred because the drywell

shell in the sand bed region was *not* coated. The exterior shell is now protected by a three-layer epoxy coating.

40. Second, if a corrosion rate of 0.017" per year had occurred between 1992 and 2006, it would have been readily detected by the VT-1 and UT performed during the 2006 refueling outage. VT-1 inspections are visual inspections performed in accordance with ASME Section XI subsection IWE, by ASME-qualified inspectors. Based on the information contained in the VT-1 inspection reports generated for the coating in all ten external drywell bays during the October 2006 outage, the epoxy coating is in good condition with no defects or deterioration.

41. AmerGen also collected UT measurement data from both the interior and exterior of the drywell shell in the sand bed region during the 2006 refueling outage. Between 1992 and 2006, the alleged rate of corrosion of 0.017" per year would have resulted in a loss of 0.238" of metal from the drywell shell (0.017" x 14 years), which would easily have been detected, as it is well within the expected equipment measurement error of 0.020". Yet the UT data, coupled with the VT-1 inspection results, confirmed that corrosion on the exterior of the drywell shell has been arrested.

42. Third, even if there was a 0.017" per year corrosion rate, Citizens only have argued that it would be localized. Specifically, Dr. Hausler, in his July 2006 memorandum, speculates that there might be tiny holes—"pinholes" or "holidays"—in the epoxy coating which could allow water to contact the exposed shell in the pinhole or holiday, causing very localized corrosion.

43. Such very localized corrosion would not call into question the appropriateness of AmerGen's UT frequency. Pinholes and holidays are analyzed against the "very local" area acceptance criterion of 0.490" which applies to areas not to exceed 2.5 inches in diameter. The thinnest external point measurement identified by Dr. Hausler was 0.618" located in Bay 13. Simple math demonstrates that there is 0.128" of margin available for a pinhole or holiday in this thinned area in Bay 13 (*i.e.*, 0.618"-0.490"), and that it would take over seven years for this margin to disappear with a corrosion rate of 0.017" per year (*i.e.*, 0.128"/0.017"). AmerGen, however, is performing UT measurements and visual inspections of the drywell shell in the sand bed region, from internal and external locations, in 2008 and then every four years.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

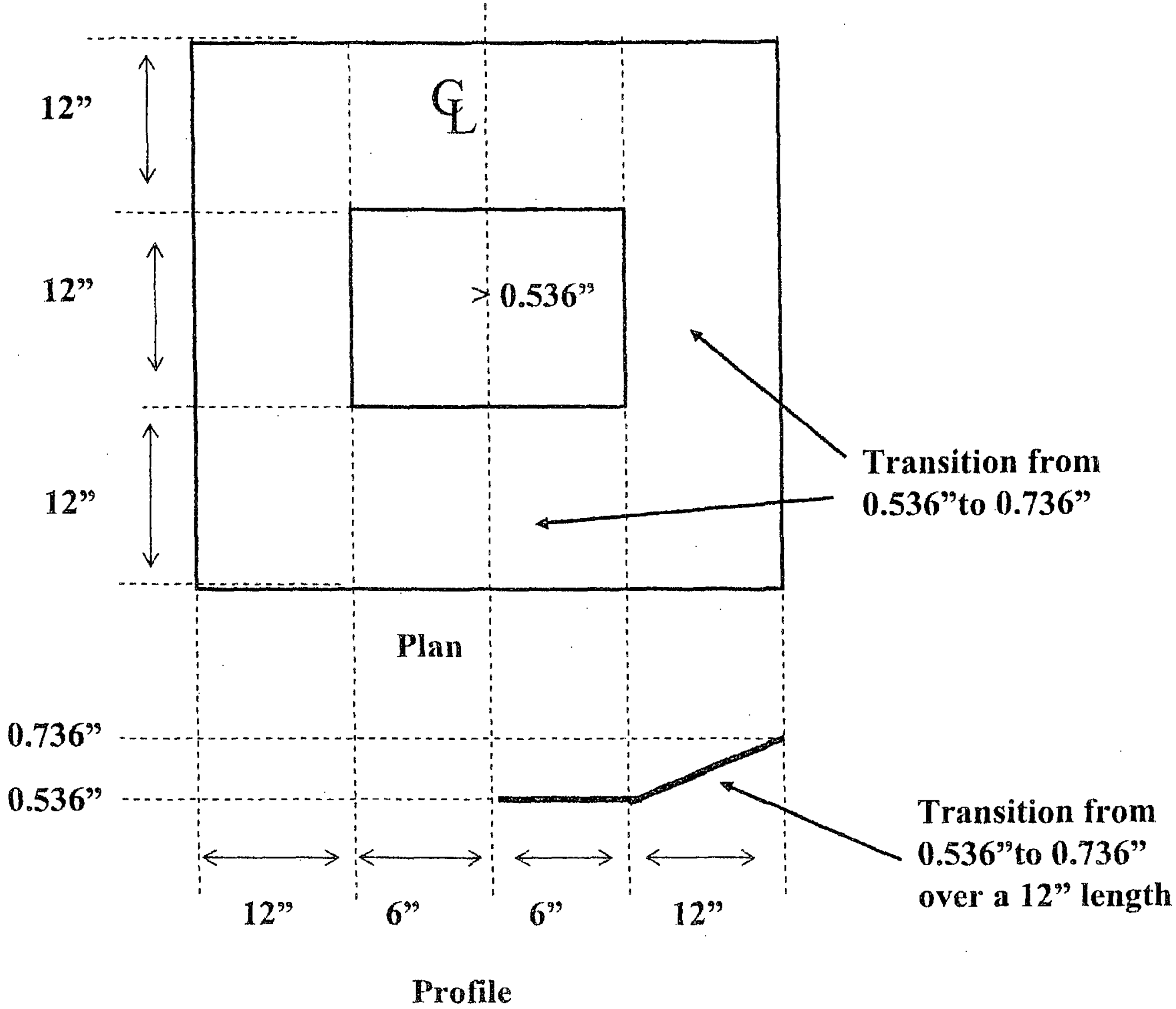
Peter Tamburro
Oyster Creek Nuclear Generating Station
Route 9
Forked River, NJ 08731

Subscribed and sworn before me this 26 day of March 2007.

Notary Public

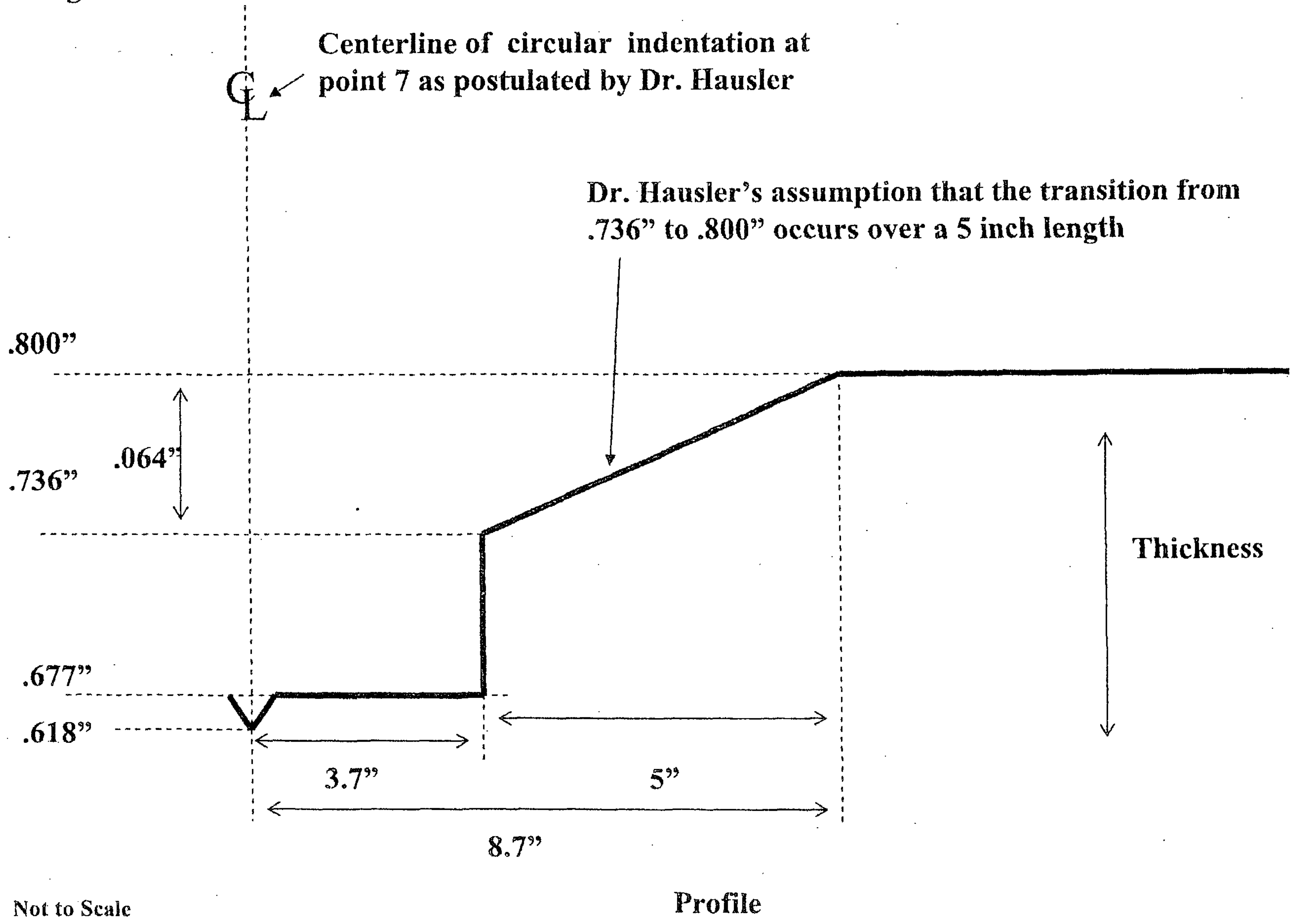
My Commission Expires: VALERIE LAUDEMAN NOTARY PUBLIC OF NEW JERSEY Commission Expires 9/26/2010

Figure 1 Schematic Demonstrating Local Area Average Acceptance Criterion



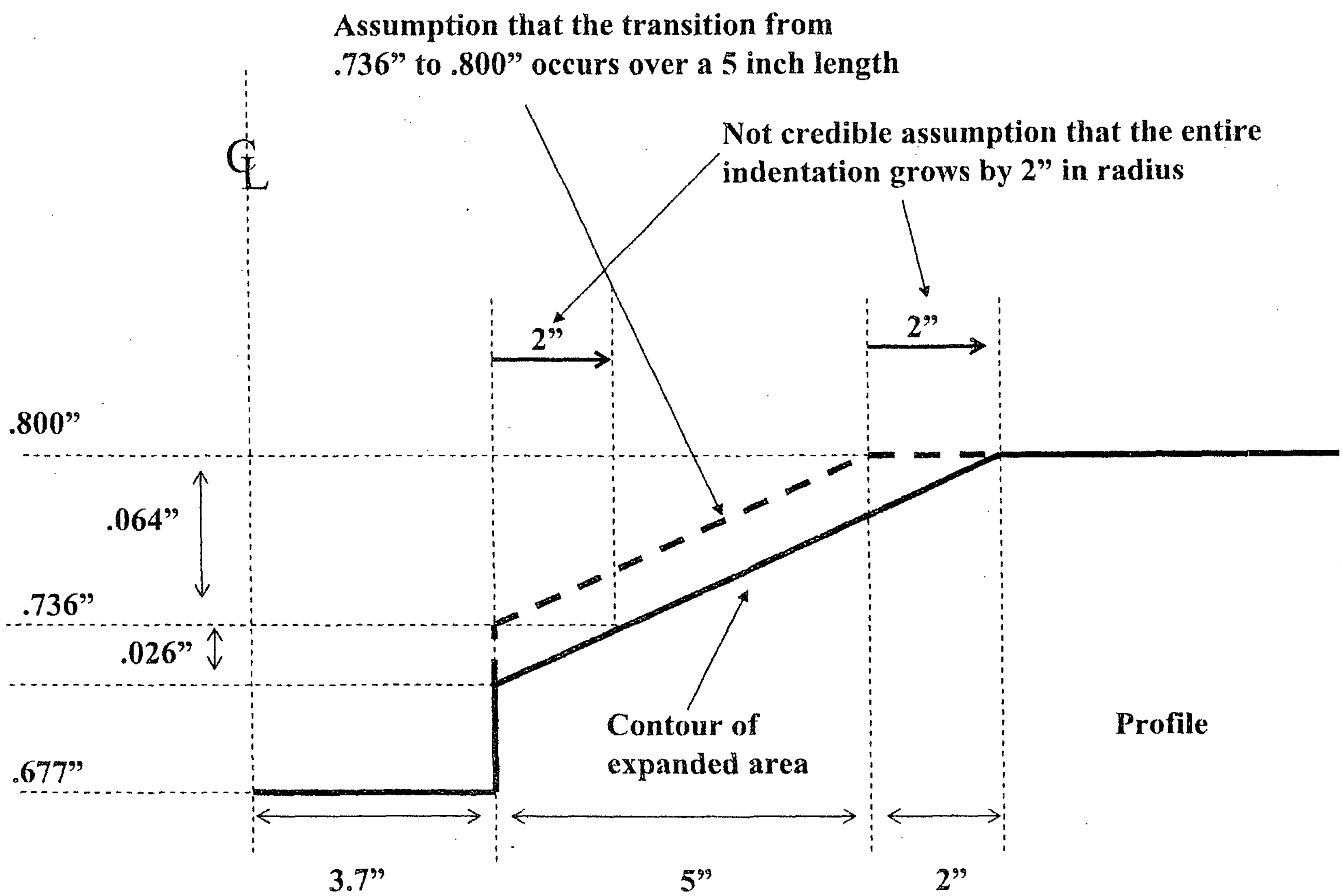
Not to Scale

Figure 2



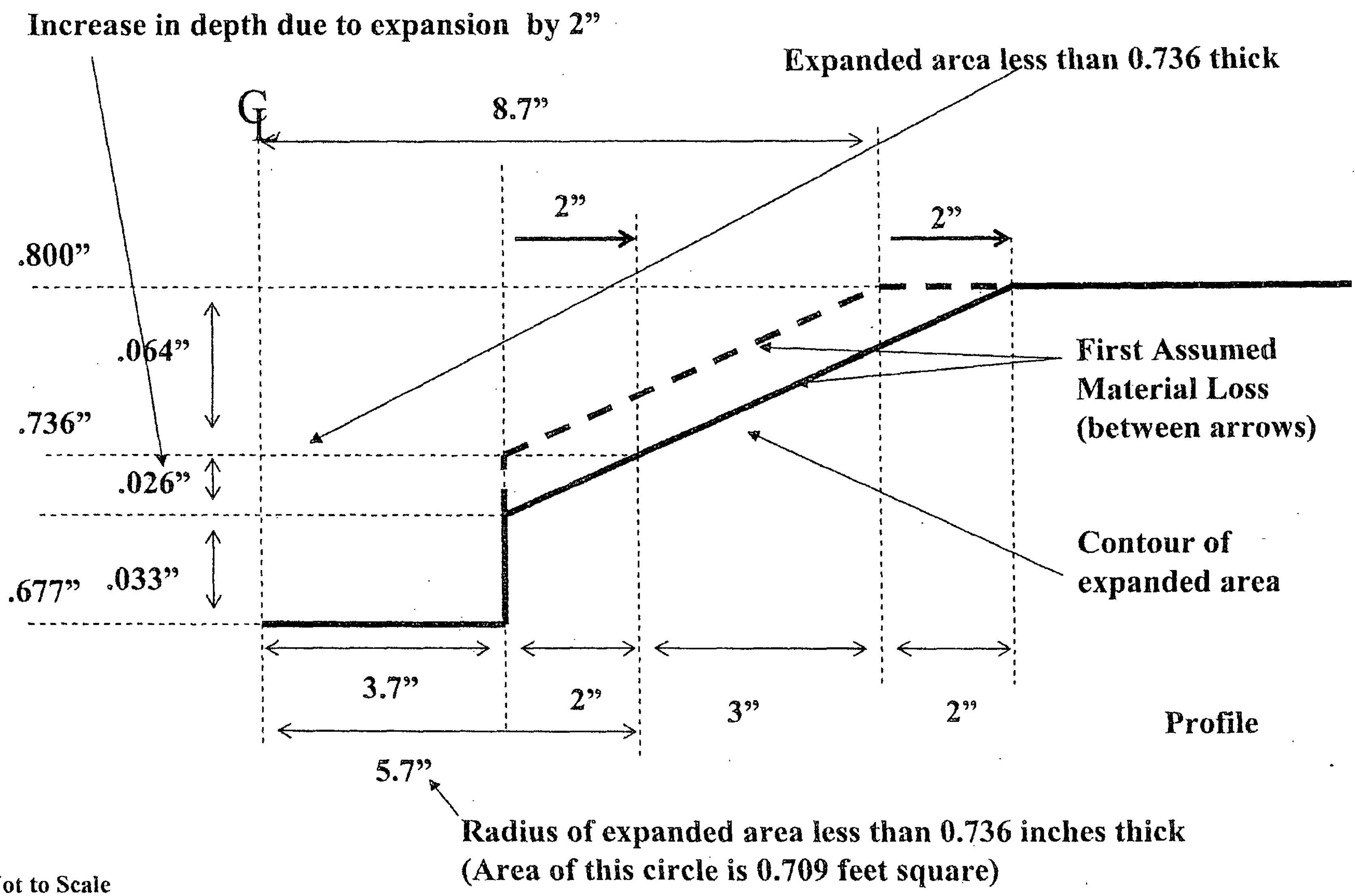
Not to Scale

Figure 3



Not to Scale

Figure 4



Not to Scale

Figure 5

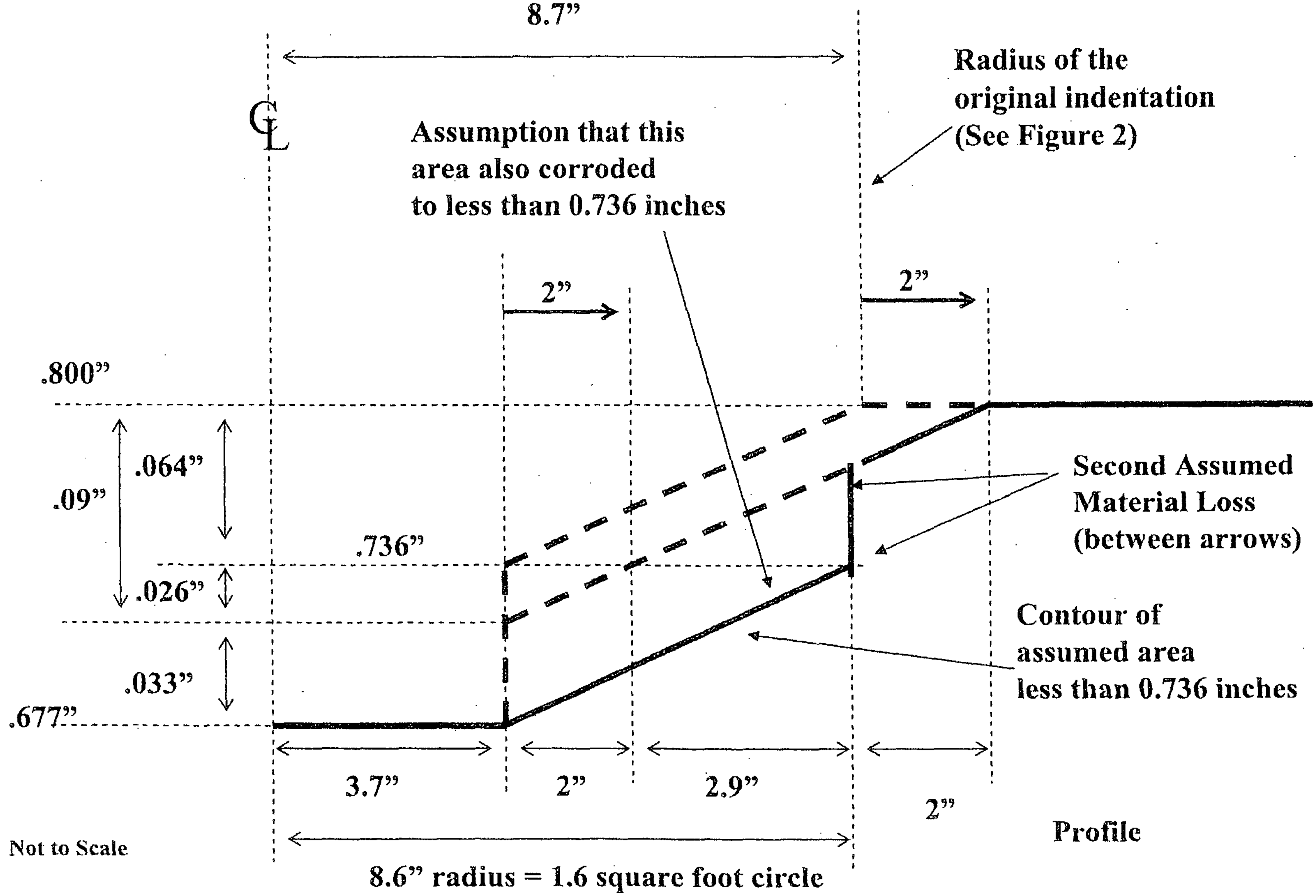


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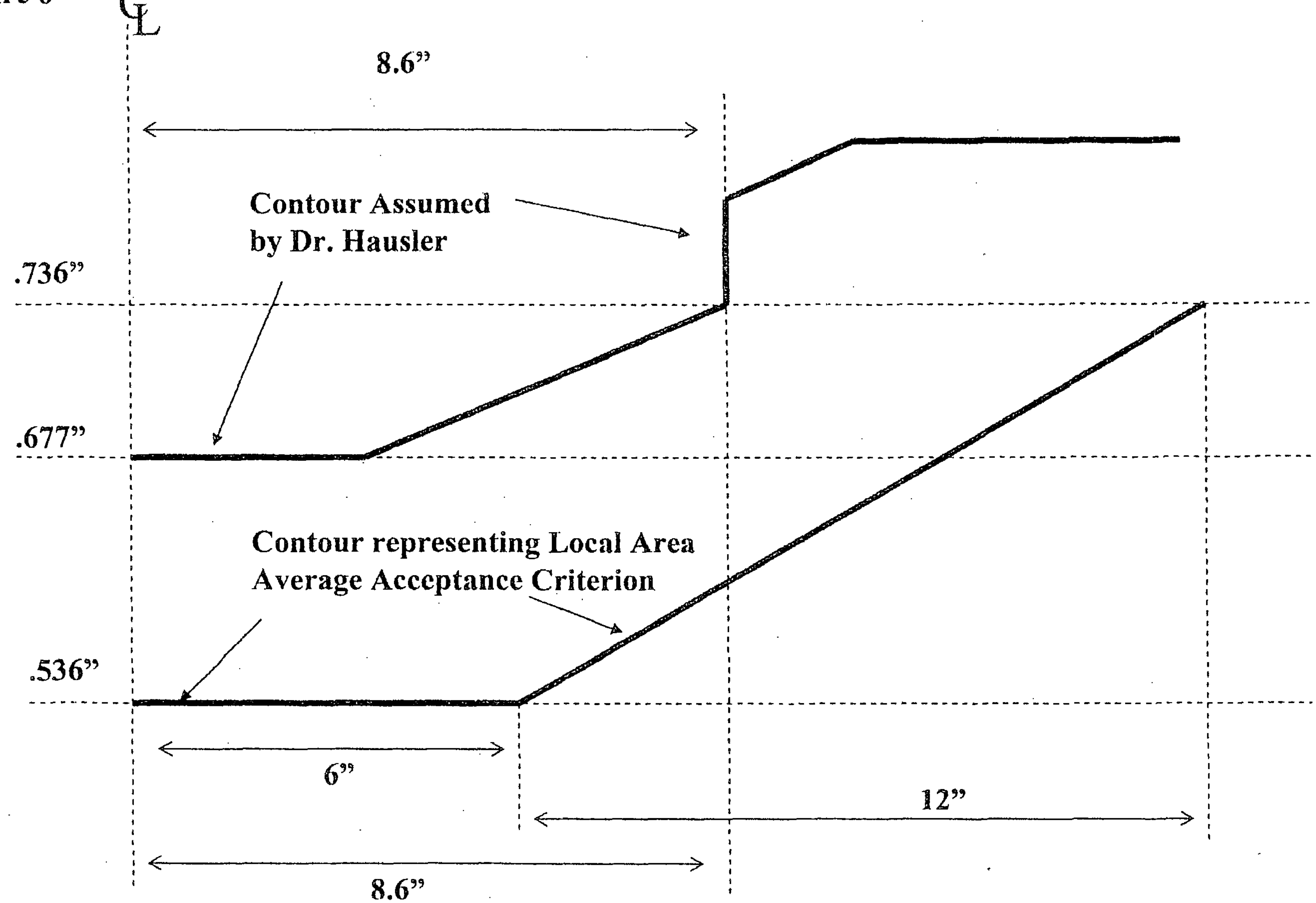
Figure 6



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Profile