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waga 1 just left of the 100 percent speed and the other  
2 larger one is the six-and-a-half and some others, you can  
3 see, these are quite a bit away from the rated speed we're  
4 talking about and they are very insignificant.

5 Q. Would it be correct that you did not  
6 consider the other orders as major orders?

7 DR. CHEN: I calculate them at the rated  
8 speed, I selected six largest orders. Those are  
9 the majors I mentioned, then I added the six largest  
10 ones.

11 Q. Dr. Chen, is there an historical reason  
12 as to why DEMA requires that major orders be assumed  
13 for determining torsional stresses?

14 DR. CHEN: It would take a lot of time to  
15 talk about historical reasons. You have to go back  
16 to the SAE, the War Engineering Board (1945) and all that, But  
17 let me be brief. In the time of the 1950's,  
18 1960s when these allowables were established as  
19 reliable figures, they were using only Holzer and forced  
20 vibration type of calculations, and at that time it  
21 was not practical or feasible to calculate many, many  
22 more orders for any reasonable degree of accuracy.

23 They were using tables, using hand  
24 calculators, and they are not trying to simulate  
25 the actual dynamic vibration. They were using the --

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1 using the major orders and see how it works and  
2 established allowable limits based on major orders and not  
3 all the orders.

4 Q. Dr. Chen, is it your testimony — strike  
5 that. I'll start over again.

6 Is it customary and accepted practice of  
7 diesel engine manufacturers in the United States in  
8 making calculations to see if their crankshafts meet  
9 DEMA allowables to utilize four to six orders to sum?

10 DR. CHEN: Yes. The major orders are  
11 picked by looking at a graph on page 16 and using  
12 only a very few of them are summed up.

13 Sometimes, only two or three of them are  
14 significant around the rates speed that we're  
15 talking about, so four or six are chosen based on  
16 engineering judgment and based on their experience  
17 using that code.

18 Q. Is it your testimony, Dr. Chen, that the  
19 replacement crankshafts comply with the DEMA  
20 allowables at 3500 kw?

21 DR. CHEN: Yes. I used, I believe,  
22 advanced methods; modal superposition or harmonic synthesis  
23 and considering shaft section by section and find the sum of  
24 (six) orders as well as single order stresses way below  
25 the DEMA allowables. And based on that

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1 DR. CHEN: There was a telephone  
2 conversation. I don't remember when. And I think  
3 some of the consultants were involved.

4 At that time my calculations methods were  
5 questioned. The disagreement of -- their  
6 disagreement of my calculations were not brought up  
7 by the Staff consultant at the time, so it was not discussed,  
8 I did not know until I see that there is a  
9 disagreement when I have a chance to review this  
10 testimony, Your Honor.

11 Q. Have you had an opportunity to review the  
12 testimony enough to discover the reasons for the  
13 disagreement?

14 DR. CHEN: Yes, I have.

15 Q. Do you agree with the arguments of the  
16 Staff?

17 DR. CHEN: No, Your Honor.

18 Q. Can you explain why?

19 DR. CHEN: I believe in the  
20 methods, and the disagreement is in this specific area that  
21 we discussed somewhat before, on how many orders we should  
22 use.

23 And I've been using the selected major orders and  
24 the Staff consultant thinks 24 orders, and I stated

25

waga 1 word "primarily" in your answer in the first -- in  
2 the second sentence in answer 46?

3 Do you have that in front of you? The  
4 phrase I'm focusing on is primarily from torsional  
5 fatigue.

6 If I remove the word "primarily," does  
7 that change the correctness of the sentence?

8 DR. CHEN: I think to a certain degree  
9 that there's crankshaft failures. The crankshaft  
10 failures for the reasons that I mentioned. For all  
11 the experts we can get together, there's always a combined  
12 stress situation. So we have to  
13 analyze very carefully whether the combined stress  
14 is primarily due to bending which is caused by  
15 misalignment or bad foundation or other reasons or  
16 overloading, or overfueling or the combined stress is  
17 primarily caused by torsionals. When you talk about combined  
18 stress, you have all those other than torsional factors  
19 involved, so I stated that primarily because of torsional,  
20 for that reason, many times we have crankshaft failures not  
21 primarily because of torsionals.

22 Sure, the torsional contributes to the combined  
23 stress, which contributes to the failures, but it is not the  
24 primary force. The torsional is not the one -- the  
25 torsional stress did not exceed the