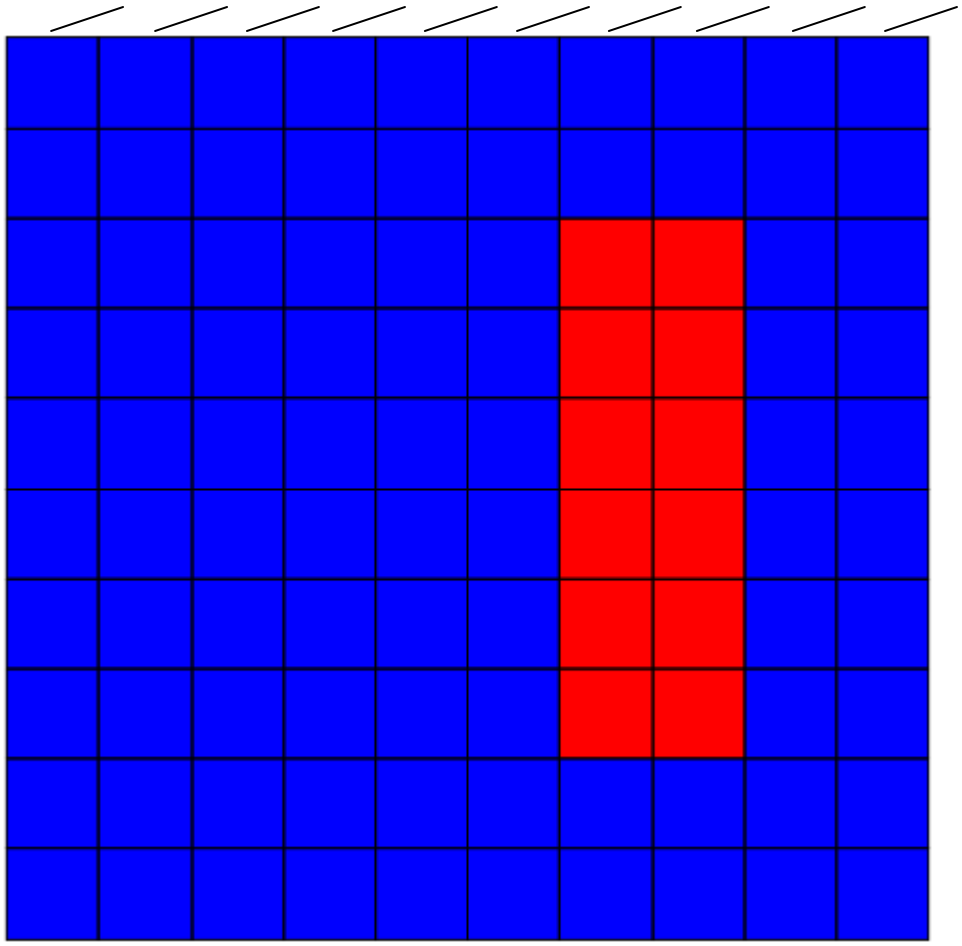
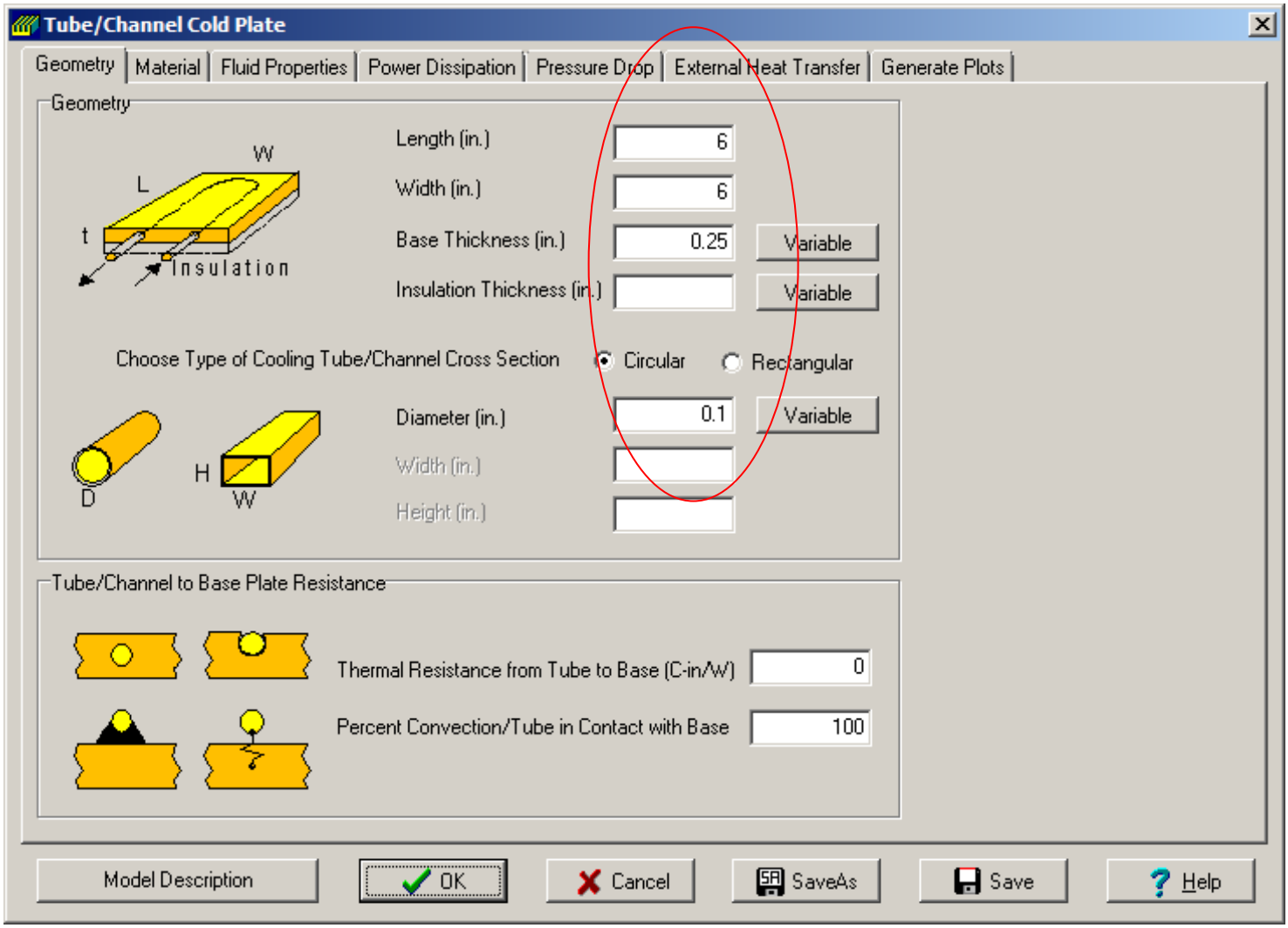
Copper Plate Example Model

Here's a demonstration of modeling a plate that is cooled by conduction to sink on one side, but without active fluid cooling through fins or a cooling tube. Assume the design parameters listed below:

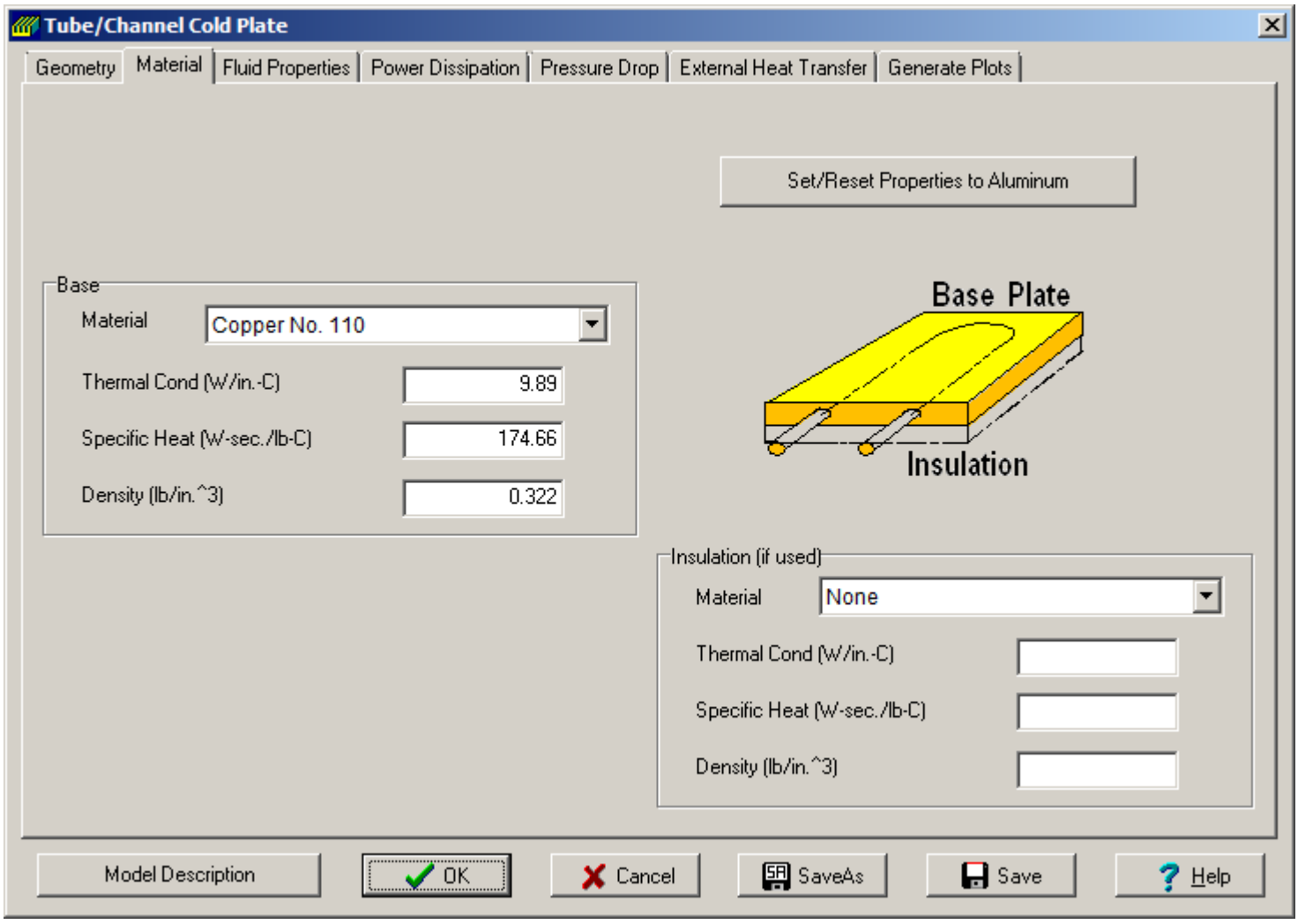
- Length L is 6 inches
- Width W is 6 inches
- Base plate is .25 inches thick
- The plate is attached to a 20C boundary along its top edge as shown below
- The thermal resistance from the plate edge to the sink is .10 C/W
- The plate is made of copper
- Assume a 10 node by 10 node model with the power dissipation as shown below with .80 Watt on each blue node and 10 Watts on each red node for a total power of 190.4 Watts.



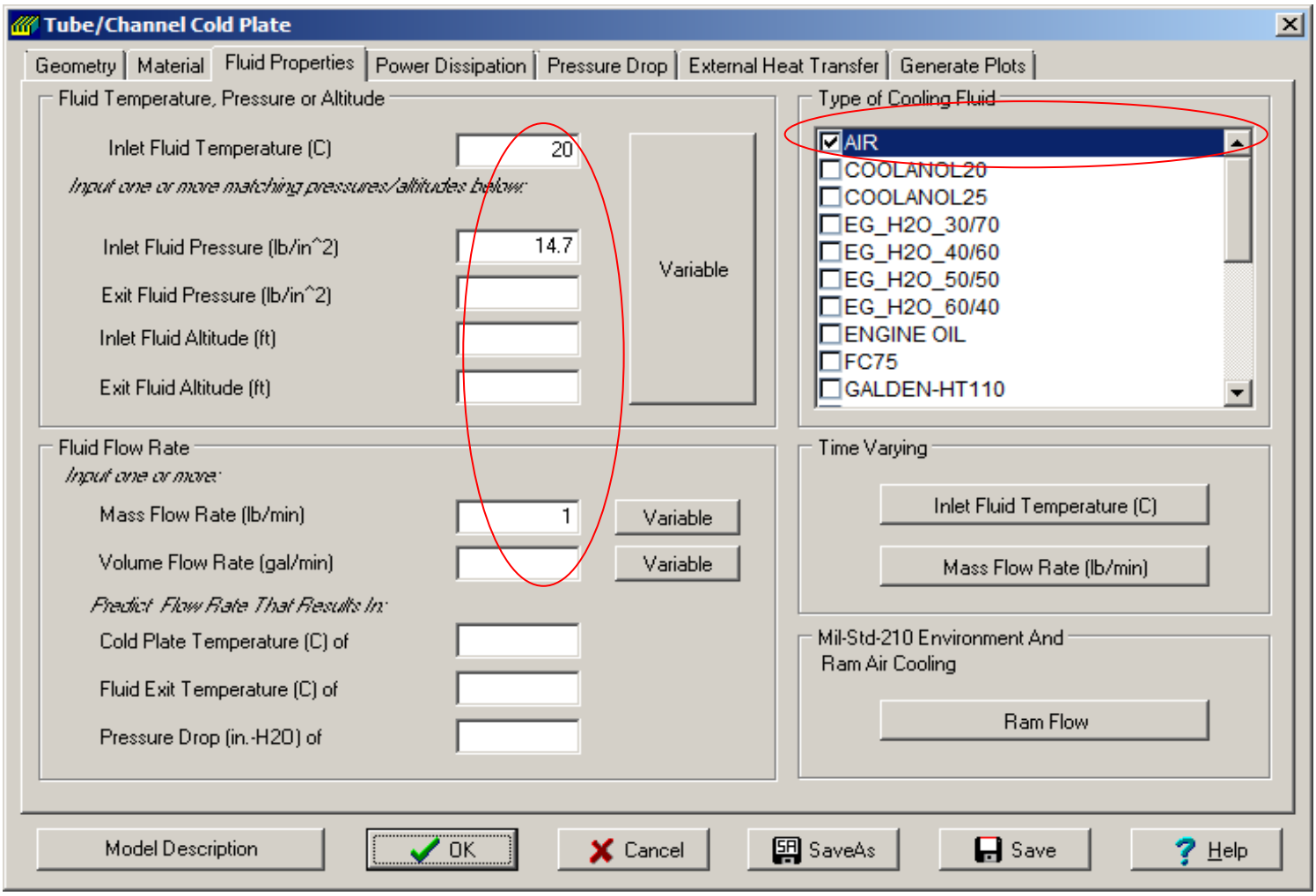
The trick to setting up this type of model is to assume that it is a tube flow cold plate but with the fluid flow turned off. In the non-isothermal part of the analysis we will tell the program that there is no flow. Of course in doing this we need to make sure that we have connected the cold plate to some type of boundary or run a transient analysis. The plate geometry is defined as shown below. We have specified a tube diameter of .1 inch, its value doesn't matter since it won't be used, and we just have to be sure to input a value.



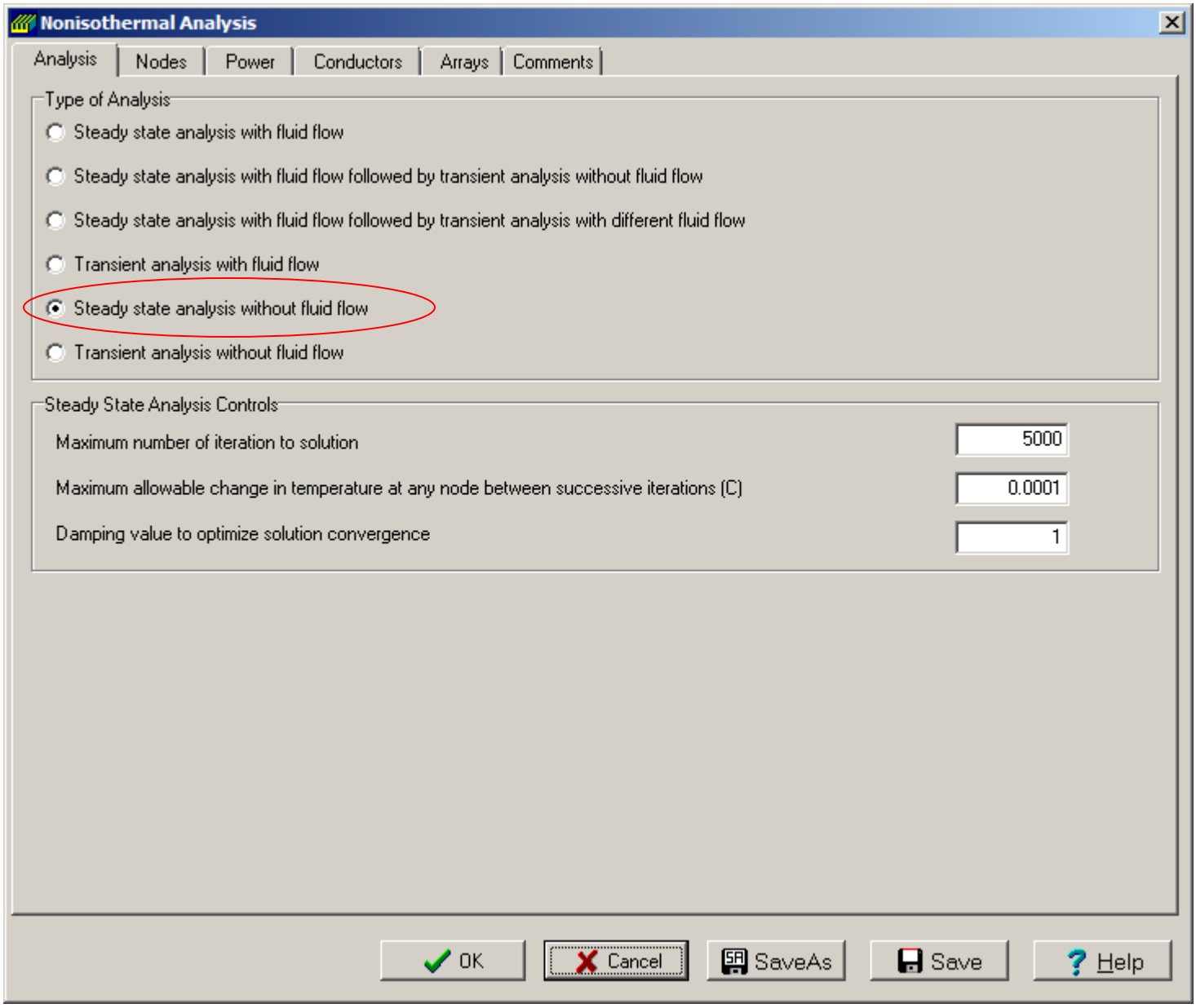
Select copper as the base plate material on the Material tab sheet.



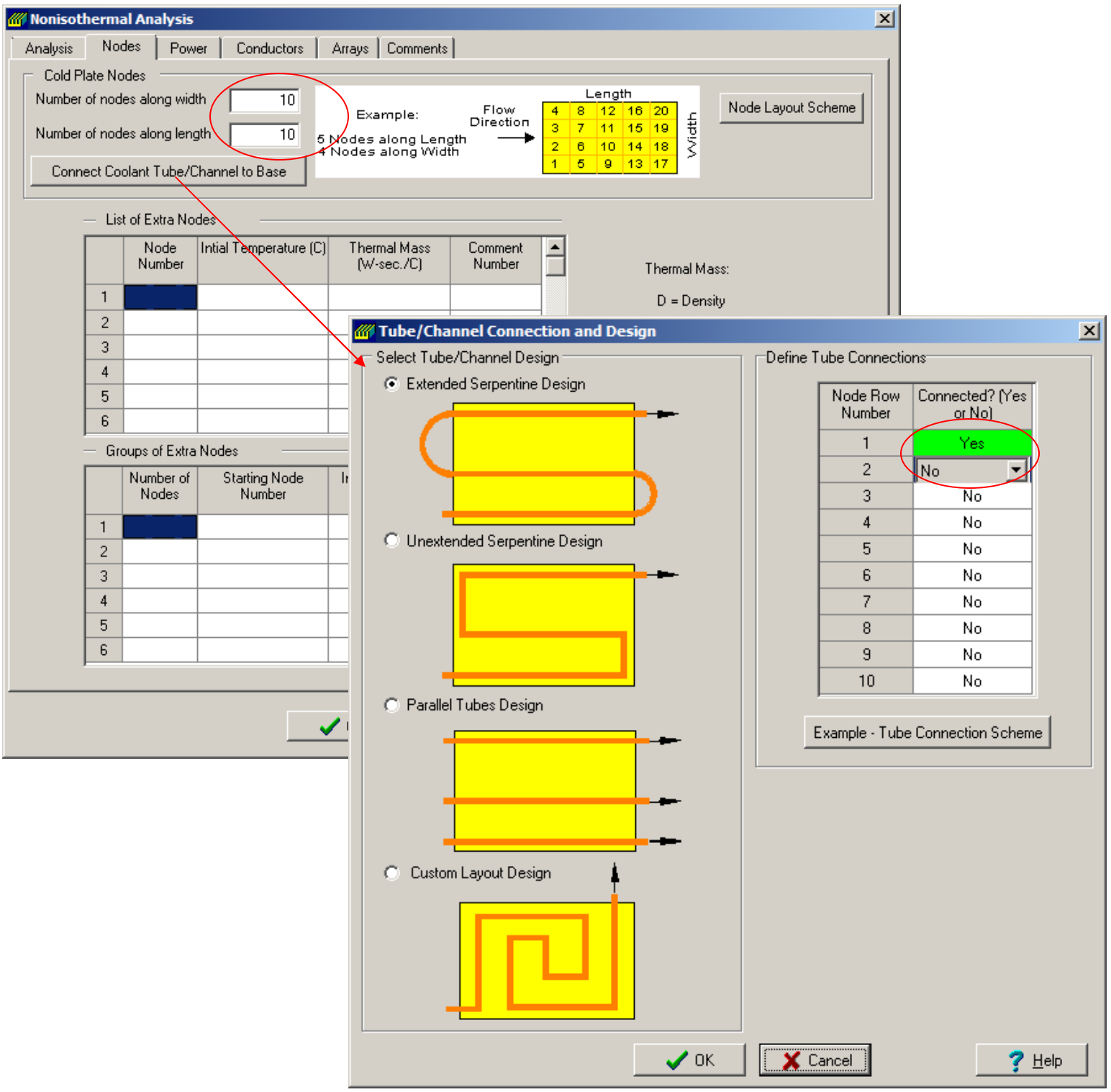
On the Fluid Properties tab sheet we again assume that this is a fluid cooled model, its values other than its temperature are ignored. The temperature will be the conduction boundary temperature that the plate is connected to. The fluid inlet node is always node 5001; this will be used later when connecting the plate to it.



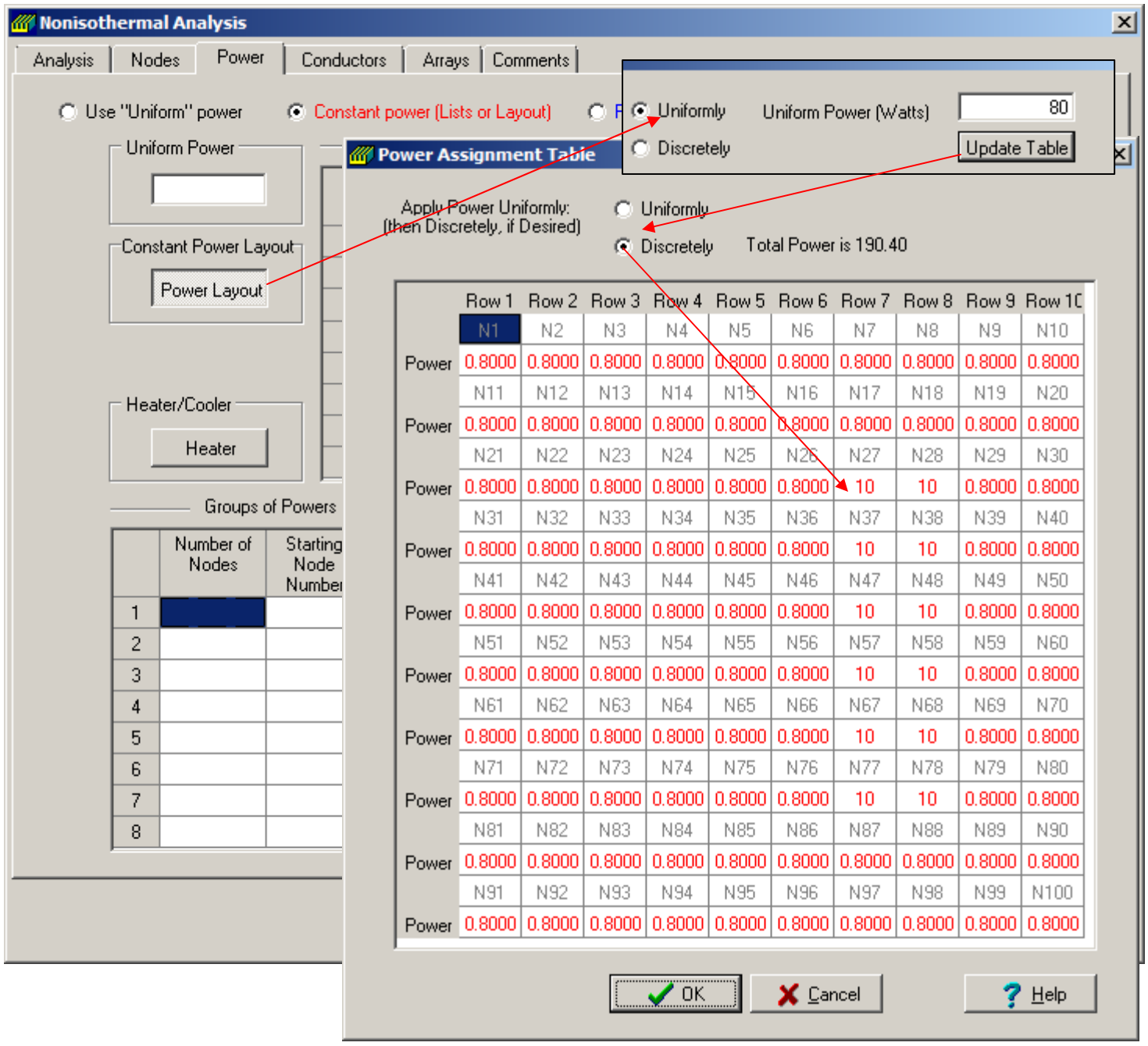
On the Nonisothermal Analysis form, select the “Steady state analysis without fluid flow” radio button to tell the program there is no fluid flow.



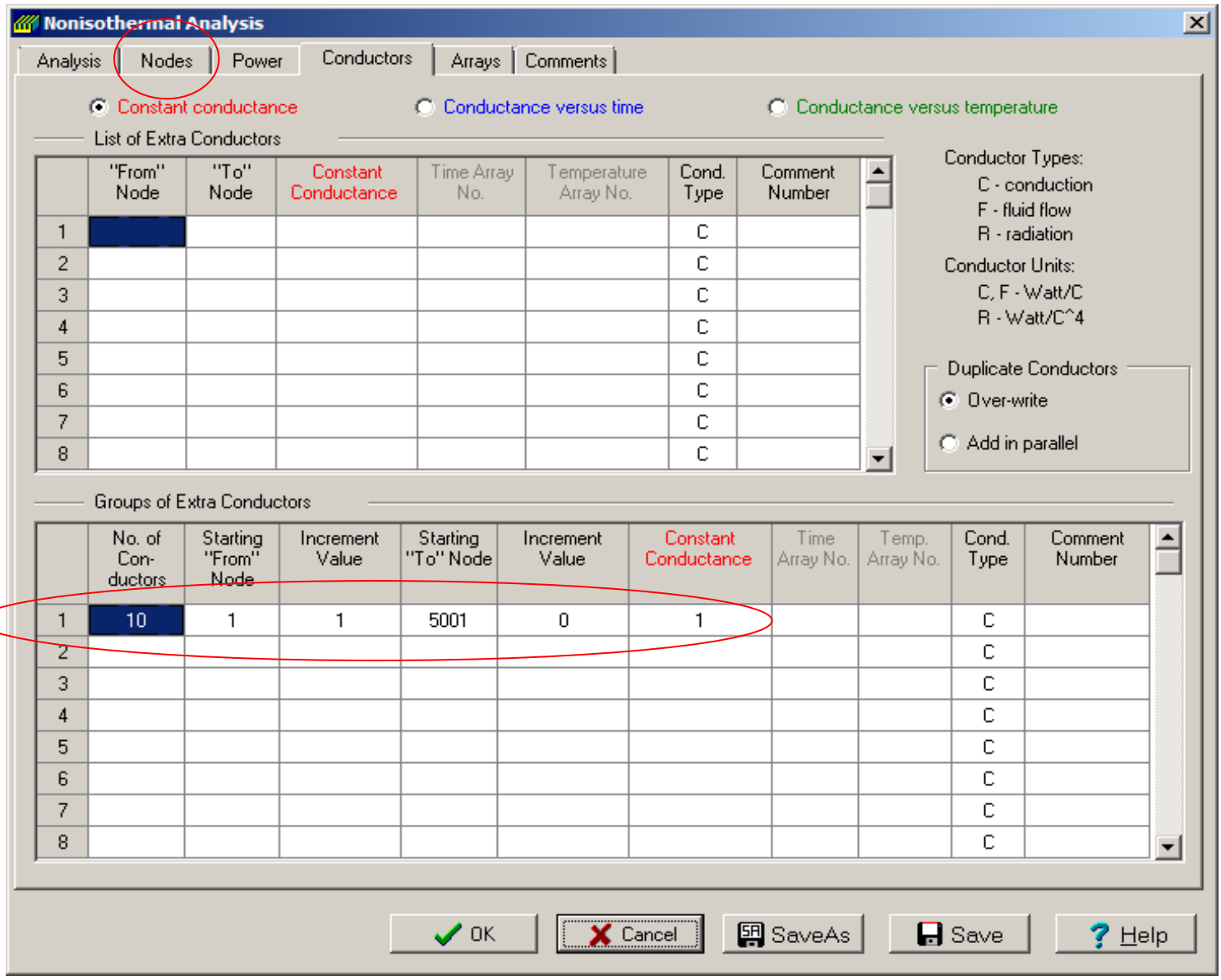
On the Nodes tab, input 10 nodes along the width and 10 nodes along the long. (The model is not restricted to these values.) Then select the "Connect Coolant Tube/Channel to Base" button and change one of the Node Row Numbers from No to Yes. It doesn't matter which one, just as long as at least one of them is connect, the connection will not be used in the analysis.



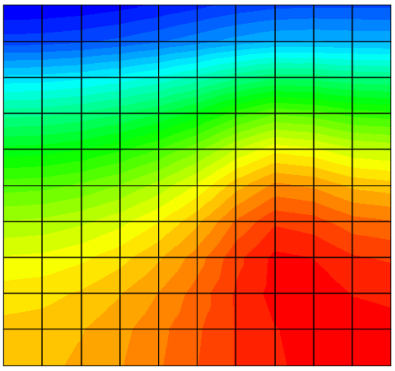
The power is input by selecting the Power tab sheet then the “Power Layout” button. On the power assignment table first select the “Uniformly” radio button, input 80 Watts (.8 Watts per node) then select the “Update Table” to uniform apply the 80 Watts. Next, select the “Discretely” radio button and then apply 10 Watts each to nodes 27,28,37,38,47,48,57,58,67,68,77,78. That takes care of the power assignment.

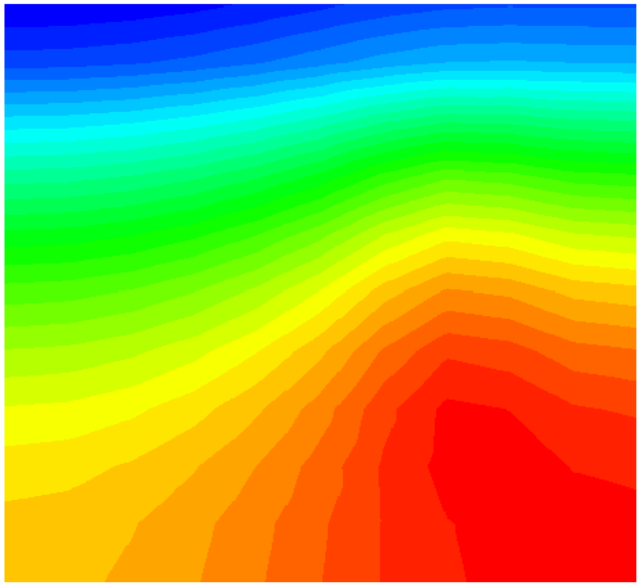


All that is left now is to tie the plate to boundary node number 5001 (the fluid inlet). As stated in the model input parameters, the total thermal resistance is .10 C/Watt. Since there are 10 nodes along the top, the resistance form each node to the boundary node is 1.0 C/Watt. But conductor values are the reciprocal of resistance, so the conductance is 1.0 Watt/C. The 10 conductors are input on a single line of input as shown below. For reference, the node numbering scheme used by COLDPLATE is shown on the Nodes tab sheet.



The results are shown below. Note that we also could have added both convection and radiation to the model by inputting the ambient and/or wall temperatures on the “External Heat Transfer” tab sheet and then specifying the external convection (node 5002) and radiation (node 5003) parameters on the same sheet.





37.0	37.2	37.6	38.1	38.8	39.6	40.3	40.7	40.6	40.6
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 1	N 2	N 3	N 4	N 5	N 6	N 7	N 8	N 9	N 10
43.4	43.6	44.2	44.9	46.0	47.3	48.6	49.0	48.7	48.5
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 11	N 12	N 13	N 14	N 15	N 16	N 17	N 18	N 19	N 20
49.2	49.5	50.2	51.2	52.6	54.6	57.3	57.9	56.5	55.8
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 21	N 22	N 23	N 24	N 25	N 26	N 27	N 28	N 29	N 30
54.3	54.7	55.5	56.7	58.5	60.8	64.1	64.8	63.0	62.2
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 31	N 32	N 33	N 34	N 35	N 36	N 37	N 38	N 39	N 40
58.7	59.2	60.0	61.4	63.3	65.9	69.4	70.2	68.3	67.4
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 41	N 42	N 43	N 44	N 45	N 46	N 47	N 48	N 49	N 50
62.4	62.9	63.8	65.2	67.1	69.8	73.3	74.1	72.3	71.4
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 51	N 52	N 53	N 54	N 55	N 56	N 57	N 58	N 59	N 60
65.4	65.8	66.7	68.0	69.9	72.5	75.9	76.7	75.0	74.2
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 61	N 62	N 63	N 64	N 65	N 66	N 67	N 68	N 69	N 70
67.5	67.9	68.8	70.0	71.8	74.0	77.0	77.8	76.5	75.9
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 71	N 72	N 73	N 74	N 75	N 76	N 77	N 78	N 79	N 80
68.9	69.3	70.1	71.3	72.8	74.5	76.2	77.0	76.9	76.7
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 81	N 82	N 83	N 84	N 85	N 86	N 87	N 88	N 89	N 90
69.7	70.0	70.8	71.9	73.2	74.7	76.0	76.8	77.0	77.0
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 91	N 92	N 93	N 94	N 95	N 96	N 97	N 98	N 99	N 100