International Technology Roadmap for Semiconductors

2000 Update

Defect Reduction

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DEFECT REDUCTION

SUMMARY

This document provides the 2000 "soft" updates to the ITRS Defect Reduction Tables # 76-80. A summary of the changes to each table is listed below.

Table 76: Yield Model and Defect Budget MPU Technology Requirements—This table was updated to reflect changes made to the Overall Roadmap Technology Characteristics (ORTC) Tables with respect to year/technology node, chip size and device pitch. Additionally an error in Random D0 calculation was caught and fixed.

Table 77: Yield Model and Defect Budget DRAM Technology Requirements—This table was updated to reflect changes made to the Overall Roadmap Technology Characteristics (ORTC) Tables with respect to year/technology node, chip size and device pitch.

Table 78a+b: Technology Requirements for Defect Detection—ITRS Node definition noted at the top updated to reflect changes made to the Overall Roadmap Technology Characteristics (ORTC) Tables with respect to year/technology node. Used for reference and perspective.

- R&D, Process, and Manufacturing Scan Speeds adjusted to a practical user standpoint as follows:
  - R&D scan speed remained the same, but an additional reference to # wafers scanned per hour included.
  - Process scan speed adjusted to a 4 wafer per hour level, which relates to expectations from manufacturing.
  - Manufacturing scan speed adjusted to a level of desire for capturing defects of the size noted in the chart.
- High Aspect Ratio defect sizes adjusted to equal Volume Manufacturing sizes at 1 X design rules. This is desired level dependent on the specific ratio.
- Backside particle size line was deleted due to no capability to measure defects at the size noted on 200mm wafers. Very little data exists for 300mm and no defect size projections have been made.
- For Defect Review, it is now labeled for Patterned Wafer. Un-patterned review is just now being documented and is scan tool sensitive.
- Under Defect Review, Coordinate Accuracy at the Defect Sizes noted in the Volume Manufacturing Size numbers gives a more understandable and direct measure for manufacturing personnel to relate to.

Table 79a+b: Defect Sources and Mechanisms Technology Requirements—This table was updated to reflect changes made to the Overall Roadmap Technology Characteristics (ORTC) Tables with respect to year/technology node.

Table 80a Defects Prevention and Elimination Technology Requirements—This table was updated to reflect changes made to the Overall Roadmap Technology Characteristics (ORTC) Tables with respect to year/technology node.

2000 Update										
Year of Production *Technology Node* **(1999 ITRS)**	*1999* *180 nm*	*2000*	*2001*	*2002* *130 nm*	*2003*	*2004*	*2005* *100 nm*	*2008* *70 nm*	*2011* *50 nm*	*2014* *35 nm*
Year of Production *Technology Node* ***(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)***	*1999* *180 nm*	*2000*	*2001* ***130 nm***	*2002*	*2003*	*2004* ***90nm***	*2005*	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

2000 Update Tables

*Table 76 Yield Model and Defect Budget MPU Technology Requirements**

Year of Introduction *"Technology Node"* **(1999 ITRS)**	*1999* *140nm*	*2000*	*2001* *100nm*	*2002*	*2003*	*2004* *70nm*	*2005*	*2008* *(50nm*)*	*2011* *(35nm*)*	*2014* *(25nm*)*
Year of Introduction *"Technology Node"* **(*SC. 2.0*)**	***1999*** ***180nm***	***2000***	***2001*** ***130nm***	***2002***	***2003***	***2004*** ***90nm***	***2005***	***2008*** ***60nm***	***2011*** ***40nm***	***2014*** ***30nm***
MPU										
MPU / ASIC 1/2 Pitch *(A)* **(1999 ITRS)**	230	210	180	160	145	130	115	81	58	41
MPU / ASIC 1/2 Pitch *(A)* **(*SC. 2.0*)**	230	***190***	***160***	***145***	***130***	***115***	***100***	***70***	***50***	***35***
Critical Defect Size **(1999 ITRS)**	115	105	90	80	73	65	58	41	29	21
Critical Defect Size **(*SC. 2.0*)**	115	***95***	***80***	***73***	***65***	***58***	***50***	***35***	***25***	***18***
Chip Size *(B)* **(1999 ITRS)**	170	170	170	191	214	224	235	269	308	354
Chip Size *(B)* **(*SC. 2.0*)**	170	170	170	***178***	***186***	***195***	***204***	***234***	***268***	***307***
Overall Electrical D0 (faults/m^2) at critical defect size or greater *(C)* **(1999 ITRS)**	1742	1742	1742	1550	1384	1322	1260	1101	961	836
Overall Electrical D0 (faults/m^2) at critical defect size or greater *(C)* **(*SC. 2.0*)**	1742	1742	1742	***1664***	***1592***	***1519***	***1452***	***1265***	***1105***	***965***
Random D0 *(faults/m^2)*(D)* **(1999 ITRS)**	373	373	373	332	296	283	270	235	206	179
Random D0 * (faults/m^2) *(D)* **(*SC. 2.0*)**	***1117***	***1117***	***1117***	***1067***	***1021***	***974***	***931***	***811***	***708***	***618***
# Mask Levels *(E)*	23	23	23	24	24	24	25	27	28	29
Random Faults/Mask **(1999 ITRS)**	16	16	16	14	12	12	11	9	7	6
Random Faults/Mask **(*SC. 2.0*)**	***49***	***49***	***49***	***44***	***43***	***41***	***37***	***30***	***25***	***21***

** In response to the observed acceleration of the Technology Nodes (TN) represented by DRAM half-pitch, the IRC proposes a new TN called Scenario 2 (SC. 2.0) for the year 2001 Renewal. The subsequent contents of this Table have been tied to update so as to reflect the new TN.*

All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node ***(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)***	1999 180 nm	2000	2001 ***130 nm***	2002	2003	2004 ***90nm***	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 76 Yield Model and Defect Budget MPU Technology Requirements (continued)**

Year of Introduction "Technology Node" **(1999 ITRS)**	1999 140nm	2000	2001 100nm	2002	2003	2004 70nm	2005	2008 (50nm*)	2011 (35nm*)	2014 (25nm*)
Year of Introduction "Technology Node" (***SC. 2.0***)	***1999 180nm***	***2000***	***2001 130nm***	***2002***	***2003***	***2004 90nm***	***2005***	***2008 60nm***	***2011 40nm***	***2014 30nm***
MPU Random Process Induced Defect (PID) Budget (defects/m2) for Generic Tool Type scaled to 75nm critical defect size or greater [E](1999 ITRS)										
CMP Clean	293	244	179	121	89	68	49	20	8	4
CMP Insulator	421	351	258	174	128	98	70	28	12	5
CMP Metal	307	256	188	127	93	71	51	20	9	4
Coat/Develop/Bake	118	99	72	49	36	27	20	8	3	1
CVD Insulator	542	452	332	224	164	126	90	36	16	7
CVD Oxide Mask	503	419	308	208	152	117	84	34	15	6
Dielectric Track	157	131	96	65	48	37	26	11	5	2
Furnace CVD	561	468	344	232	170	130	93	37	16	7
Furnace Fast Ramp	196	164	120	81	59	46	33	13	6	2
Furnace Oxide/Anneal	269	224	165	111	81	62	45	18	8	3
Implant High Current	462	385	283	191	140	107	77	31	13	6
Implant Low/Med Current	403	336	247	166	122	94	67	27	12	5
Inspect PLY	165	138	101	68	50	38	28	11	5	2
Inspect Visual	187	156	115	77	57	43	31	12	5	2
Litho Cell	183	152	112	75	55	42	30	12	5	2
Litho Stepper	87	73	53	36	26	20	15	6	3	1
Measure CD	181	151	111	75	55	42	30	12	5	2
Measure Film	202	168	124	83	61	47	34	13	6	2
Measure Overlay	165	138	101	68	50	38	28	11	5	2
Metal CVD	263	219	161	109	80	61	44	18	8	3
Metal Electroplate	157	131	96	65	48	37	26	11	5	2
Metal Etch	611	509	374	252	185	142	102	41	18	7
Metal PVD	392	326	240	162	118	91	65	26	11	5
Plasma Etch	576	481	353	238	174	134	96	38	17	7
Plasma Strip	401	334	245	165	121	93	67	27	12	5
RTP CVD	171	143	105	71	52	40	28	11	5	2
RTP Oxide/Anneal	118	99	72	49	36	27	20	8	3	1
Test	64	54	39	27	19	15	11	4	2	1
Vapor Phase Clean	428	357	262	177	130	100	71	29	12	5
Wafer Handling	25	21	15	10	8	6	4	2	1	0.3
Wet Bench	446	371	273	184	135	104	74	30	13	5

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2000 Update										
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Year of Production Technology Node **(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 NM]**	2011 **[40 NM]**	2014 **[30 NM]**

*Table 76 Yield Model and Defect Budget MPU Technology Requirements (continued)**

Year of Introduction "Technology Node" **(1999 ITRS)**	1999 140nm	2000	2001 100nm	2002	2003	2004 70nm	2005	2008 (50nm*)	2011 (35nm*)	2014 (25nm*)
Year of Introduction "Technology Node" (**SC. 2.0**)	**1999 180nm**	**2000**	**2001 130nm**	**2002**	**2003**	**2004 90nm**	**2005**	**2008 60nm**	**2011 40nm**	**2014 30nm**
MPU Random Process Induced Defect (PID) Budget (defects/m2) for Generic Tool Type scaled to 75nm critical defect size or greater [E]										
CMP Clean	263	179	127	96	74	55	38	15	6	3
CMP Insulator	378	258	183	138	106	79	55	22	9	4
CMP Metal	275	188	133	100	77	57	40	16	7	3
Coat/Develop/Bake	106	72	51	39	30	22	15	6	3	1
CVD Insulator	486	332	235	177	136	102	70	28	12	5
CVD Oxide Mask	451	308	218	164	126	94	65	26	11	5
Dielectric Track	141	96	68	51	40	29	20	8	3	1
Furnace CVD	504	344	244	183	141	105	73	29	12	5
Furnace Fast Ramp	176	120	85	64	49	37	26	10	4	2
Furnace Oxide/Anneal	241	165	117	88	67	50	35	14	6	2
Implant High Current	414	283	200	151	116	87	60	24	10	4
Implant Low/Med Current	362	247	175	132	101	76	52	21	9	4
Inspect PLY	148	101	72	54	42	31	22	9	4	2
Inspect Visual	168	115	81	61	47	35	24	10	4	2
Litho Cell	164	112	79	60	46	34	24	9	4	2
Litho Stepper	78	53	38	28	22	16	11	4	2	1
Measure CD	163	111	79	59	46	34	24	9	4	2
Measure Film	181	124	88	66	51	38	26	10	4	2
Measure Overlay	148	101	72	54	42	31	22	9	4	2
Metal CVD	236	161	114	86	66	49	34	14	6	2
Metal Electroplate	141	96	68	51	40	29	20	8	3	1
Metal Etch	548	374	265	199	153	115	79	31	14	6
Metal PVD	351	240	170	128	98	73	51	20	9	4
Plasma Etch	517	353	250	188	145	108	75	30	13	5
Plasma Strip	360	245	174	131	101	75	52	21	9	4
RTP CVD	154	105	74	56	43	32	22	9	4	2
RTP Oxide/Anneal	106	72	51	39	30	22	15	6	3	1
Test	58	39	28	21	16	12	8	3	1	1
Vapor Phase Clean	384	262	186	140	108	80	56	22	9	4
Wafer Handling	23	15	11	8	6	5	3	1	1	0.2
Wet Bench	400	273	194	145	112	84	58	23	10	4

(A): As defined in the ORTC Table 1a. ***(B): As defined in the ORTC Table 2a.***
(C): As defined in the ORTC Table 5a.
(D): Based on assumption of 89.5% Random Defect Limited Yield (RDLY) and peripheral area = (1 - Cell Array Area) times overall chip size
(E): Random PID Budget Numbers are based on 1999 SEMATECH 150nm RDLY Model Validation Project
(F): FEOL - front end of line ***(G): BEOL - back end of line***

** In response to the observed acceleration of the Technology Nodes (TN) represented by DRAM half-pitch, the IRC proposes a new TN called Scenario 2 (SC. 2.0) for the year 2001 Renewal. The subsequent contents of this Table have been tied to update so as to reflect the new TN.*

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2000 Update										
Year of Production Technology Node **(1999 ITRS)**	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node **(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

Table 77 Yield Model and Defect Budget DRAM Technology Requirements*

Year of Introduction "Technology Node"	1999 180nm	2000	2001	2002 130nm	2003	2004	2005 100nm	2008 70nm	2011 50nm	2014 35nm
Year of Introduction "Technology Node" (**SC. 2.0**)	1999 180nm	2000	**2001 130nm**		**2003**	**2004 90nm**	**2005**	**2008 60nm**	**2011 40nm**	**2014 30nm**
DRAM										
DRAM 1/2 Pitch *(A)* **(1999 ITRS)**	180	165	150	130	120	110	100	70	50	35
DRAM 1/2 Pitch *(A)* (**SC. 2.0**)	180	**150**	**130**	**115**	**100**	**90**	**80**	**60**	**40**	**30**
Critical Defect Size **(1999 ITRS)**	90	83	75	65	60	55	50	35	25	18
Critical Defect Size (**SC. 2.0**)	90	**75**	**65**	**58**	**50**	**45**	**40**	**30**	**20**	**15**
Chip Size *(B)* **(1999 ITRS)**	132	138	145	152	159	166	174	199	229	262
Chip Size *(B)* (**SC. 2.0**)	**131**	**129**	**127**	**141**	**157**	**175**	**147**	**205**	**191**	**268**
Cell Array Area (%) (NEW LINE)	**53.0%**	**54.0%**	**54.8%**	**55.3%**	**55.7%**	**56.1%**	**56.4%**	**57.3%**	**57.8%**	**58.2%**
Overall Electrical D0 (faults/m^2) at critical defect size or > *(C)* **1999 ITRS)**	1249	1193	1140	1089	1040	994	950	828	723	630
Overall Electrical D0 (faults/m^2) at critical defect size or greater *(C)*(**SC. 2.0**)	**1261**	**1281**	**1301**	**1172**	**1052**	**944**	**1124**	**806**	**865**	**616**
Random D0 * (faults/m^2) *(D)* **(1999 ITRS)**	2826	2700	2580	2465	2355	2250	2150	1875	1636	1426
Random D0 * (faults/m^2) *(D)* (**SC. 2.0**)	**1822**	**1890**	**1954**	**1780**	**1613**	**1460**	**1750**	**1281**	**1392**	**1001**
# Mask Levels	20	20	20	21	21	21	22	24	25	26
Random Faults/Mask **(1999 ITRS)**	141	135	129	117	112	107	98	78	65	55
Random Faults/Mask (**SC. 2.0**)	**91**	**95**	**98**	**85**	**77**	**70**	**80**	**53**	**56**	**39**

** In response to the observed acceleration of the Technology Nodes (TN) represented by DRAM half-pitch, the IRC proposes a new TN called Scenario 2 (SC. 2.0) for the year 2001 Renewal. The subsequent contents of this Table have been tied to update so as to reflect the new TN.*

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2000 Update										
Year of Production Technology Node **(1999 ITRS)**	*1999* *180 nm*	*2000*	*2001*	*2002* *130 nm*	*2003*	*2004*	*2005* *100 nm*	*2008* *70 nm*	*2011* *50 nm*	*2014* *35 nm*
Year of Production Technology Node ***(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)***	*1999* *180 nm*	*2000*	*2001* ***130 nm***	*2002*	*2003*	*2004* ***90nm***	*2005*	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 77 Yield Model and Defect Budget DRAM Technology Requirements (continued)**

Year of Introduction *"Technology Node"*	*1999* *180nm*	*2000*	*2001*	*2002* *130nm*	*2003*	*2004*	*2005* *100nm*	*2008* *70nm*	*2011* *50nm*	*2014* *35nm*
Year of Introduction *"Technology Node" (**SC. 2.0**)*	*1999* *180nm*	*2000*	***2001*** ***130nm***		***2003***	***2004*** ***90nm***	***2005***	***2008*** ***60nm***	***2011*** ***40nm***	***2014*** ***30nm***
DRAM Random Process Induced Defect (PID) Budget (defects/m2) for Generic Tool Type scaled to 75nm critical defect size or greater [E] (1999 ITRS)										
CMP Clean	758	608	480	328	267	215	162	65	27	11
CMP Insulator	1090	875	691	472	385	309	233	93	39	16
CMP Metal	793	637	503	344	280	225	169	68	28	12
Coat/Develop/Bake	306	246	194	133	108	87	65	26	11	4
CVD Insulator	1402	1126	889	608	495	397	299	120	50	21
CVD Oxide Mask	1301	1045	825	564	459	369	278	111	46	19
Dielectric Track	407	327	258	176	144	115	87	35	15	6
Furnace CVD	1453	1166	921	629	512	411	310	124	52	21
Furnace Fast Ramp	508	408	322	220	179	144	108	43	18	7
Furnace Oxide/Anneal	695	558	441	301	245	197	148	59	25	10
Implant High Current	1194	959	757	517	421	338	255	102	43	18
Implant Low/Med Current	1043	837	661	452	368	295	223	89	37	15
Inspect PLY	428	343	271	185	151	121	91	37	15	6
Inspect Visual	484	389	307	210	171	137	103	41	17	7
Litho Cell	472	379	299	205	167	134	101	40	17	7
Litho Stepper	226	181	143	98	80	64	48	19	8	3
Measure CD	469	377	298	203	166	133	100	40	17	7
Measure Film	523	420	331	227	184	148	112	45	19	8
Measure Overlay	428	343	271	185	151	121	91	37	15	6
Metal CVD	680	546	431	295	240	193	145	58	24	10
Metal Electroplate	407	327	258	176	144	115	87	35	15	6
Metal Etch	1581	1269	1002	685	558	448	337	135	56	23
Metal PVD	1013	813	642	439	357	287	216	86	36	15
Plasma Etch	1491	1197	945	646	526	422	318	127	53	22
Plasma Strip	1037	832	657	449	366	294	221	88	37	15
RTP CVD	443	355	281	192	156	125	94	38	16	6
RTP Oxide/Anneal	306	246	194	133	108	87	65	26	11	4
Test	166	134	105	72	59	47	36	14	6	2
Vapor Phase Clean	1108	890	703	480	391	314	237	95	40	16
Wafer Handling	65	52	41	28	23	19	14	6	2	1.0
Wet Bench	1153	925	731	499	407	326	246	98	41	17

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2000 UPDATE										
YEAR OF PRODUCTION TECHNOLOGY NODE (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
YEAR OF PRODUCTION TECHNOLOGY NODE **(PROPOSED NODE YEARS ARE NOW 2007/65NM; 2010/45NM; 2013/33NM; 2016/23NM) (SC. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 NM]**	2011 **[40 NM]**	2014 **[30 NM]**

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Year of Introduction "Technology Node"	1999 180nm	2000	2001	2002 130nm	2003	2004	2005 100nm	2008 70nm	2011 50nm	2014 35nm
Year of Introduction "Technology Node" (**SC. 2.0**)	1999 180nm	2000	**2001** **130nm**		**2003**	**2004** **90nm**	**2005**	**2008** **60nm**	**2011** **40nm**	**2014** **30nm**
DRAM Random Process Induced Defect (PID) Budget (Defects/m2) for Generic Tool Type Scaled to 75nm critical defect size or greater [E] (**SC.**										
CMP Clean	**551**	**480**	**410**	**267**	**206**	**157**	**148**	**49**	**26**	**9**
CMP Insulator	**793**	**691**	**591**	**385**	**297**	**226**	**214**	**70**	**37**	**13**
CMP Metal	**577**	**503**	**430**	**280**	**216**	**164**	**155**	**51**	**27**	**9**
Coat/Develop/Bake	**222**	**194**	**166**	**108**	**83**	**63**	**60**	**20**	**10**	**4**
CVD Insulator	**1020**	**889**	**759**	**495**	**382**	**291**	**275**	**90**	**48**	**16**
CVD Oxide Mask	**946**	**825**	**705**	**459**	**355**	**270**	**255**	**84**	**45**	**15**
Dielectric Track	**296**	**258**	**220**	**144**	**111**	**84**	**80**	**26**	**14**	**5**
Furnace CVD	**1056**	**921**	**787**	**513**	**396**	**301**	**285**	**94**	**50**	**17**
Furnace Fast Ramp	**369**	**322**	**275**	**179**	**138**	**105**	**100**	**33**	**17**	**6**
Furnace Oxide/Anneal	**505**	**441**	**377**	**245**	**189**	**144**	**136**	**45**	**24**	**8**
Implant High Current	**868**	**757**	**647**	**421**	**325**	**248**	**234**	**77**	**41**	**14**
Implant Low/Med Current	**758**	**661**	**565**	**368**	**284**	**216**	**204**	**67**	**36**	**12**
Inspect PLY	**311**	**271**	**232**	**151**	**117**	**89**	**84**	**28**	**15**	**5**
Inspect Visual	**352**	**307**	**262**	**171**	**132**	**100**	**95**	**31**	**17**	**6**
Litho Cell	**343**	**299**	**256**	**167**	**129**	**98**	**93**	**30**	**16**	**5**
Litho Stepper	**164**	**143**	**122**	**80**	**62**	**47**	**44**	**15**	**8**	**3**
Measure CD	**341**	**298**	**254**	**166**	**128**	**97**	**92**	**30**	**16**	**5**
Measure Film	**380**	**331**	**283**	**185**	**142**	**108**	**102**	**34**	**18**	**6**
Measure Overlay	**311**	**271**	**232**	**151**	**117**	**89**	**84**	**28**	**15**	**5**
Metal CVD	**495**	**431**	**368**	**240**	**185**	**141**	**133**	**44**	**23**	**8**
Metal Electroplate	**296**	**258**	**220**	**144**	**111**	**84**	**80**	**26**	**14**	**5**
Metal Etch	**1149**	**1002**	**856**	**558**	**431**	**328**	**310**	**102**	**54**	**18**
Metal PVD	**737**	**642**	**549**	**357**	**276**	**210**	**199**	**65**	**35**	**12**
Plasma Etch	**1084**	**945**	**808**	**526**	**406**	**309**	**292**	**96**	**51**	**17**
Plasma Strip	**754**	**657**	**562**	**366**	**283**	**215**	**203**	**67**	**36**	**12**
RTP CVD	**322**	**281**	**240**	**156**	**121**	**92**	**87**	**29**	**15**	**5**
RTP Oxide/Anneal	**223**	**194**	**166**	**108**	**83**	**63**	**60**	**20**	**10**	**4**
Test	**121**	**105**	**90**	**59**	**45**	**34**	**33**	**11**	**6**	**2**
Vapor Phase Clean	**806**	**703**	**600**	**391**	**302**	**230**	**217**	**71**	**38**	**13**
Wafer Handling	**48**	**41**	**35**	**23**	**18**	**14**	**13**	**4**	**2**	**0.8**
Wet Bench	**838**	**731**	**624**	**407**	**314**	**239**	**226**	**74**	**40**	**13**

(A): As defined in the ORTC Table 1a. (B): As defined in the ORTC Table 2a. (C): As defined in the ORTC Table 5a.
(D): Based on assumption of 89.5% Random Defect Limited Yield (RDLY) and peripheral area = (1 - Cell Array Area) times overall chip size
(E): Random PID Budget Numbers are based on 1999 SEMATECH 150nm RDLY Model Validation Project
(F): FEOL - front end of line (G): BEOL - back end of line

** In response to the observed acceleration of the Technology Nodes (TN) represented by DRAM half-pitch, the IRC proposes a new TN called Scenario 2 (SC. 2.0) for the year 2001 Renewal. The subsequent contents of this Table have been tied to update so as to reflect the new TN.*

All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node **(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 78a Technology Requriements for Defect Detection — Near Term**

(Node = 1/2 Dram Metal 1 Pitch)

Year Technology Node	1999 180 nm	2000	2001 130 nm	2002	2003	2004 90 nm	2005	Driver
*Patterned Wafer Inspection, PSL Spheres at 90% Capture, Equivalent Sensitivity (nm) *[A, B]*								
Process R&D at 300 cm2/hr (1999 ITRS)	54	49	39	36	33	27	24	0.3 x DR
Process R&D at 300 cm2/hr - 1 W/hr (Sc. 2.0)	**108**	**98**	**78**	**72**	**66**	**54**	**48**	**0.6 x DR**
Yield Ramp at 3000 cm2/hr (1999 ITRS)	72	65	52	48	44	36	31	0.4 xDR
Yield Ramp at 1200 cm2/hr - 4W/hr (Sc. 2.0)	**144**	**131**	**104**	**96**	**88**	**72**	**56**	**0.8 x DR**
Volume Production at 10000 cm2/hr (1999 ITRS)	90	81	65	60	55	45	35	0.5 x DR
Volume Production at 3000 cm2/hr - 10W/hr (Sc. 2.0)	**180**	**150**	**130**	**120**	**110**	**90**	**80**	**1.0 x DR**
High Aspect Ratio Feature Inspection: Defects other than Residue, Equivalent Sensitivity in PSL Diameter(nm) at 90%								
All stages of manufacturing (1999 ITRS)	54	49	39	36	33	27	24	0.3 x DR
All stages of manufacturing (**Sc. 2.0**)	**180**	**150**	**130**	**120**	**110**	**90**	**80**	**1.0 x DR**
*Unpatterned, PSL Spheres at 90% Capture, Equivalent Sensitivity (nm) *[D, E]*								
Metal Film (1999 ITRS)	69	63	51	47	43	35	30	0.3 x DR
Metal Film (**Sc. 2.0**)	**138**	**127**	**101**	**94**	**86**	**70**	**62**	**0.6 x DR**
Nonmetal Films (1999 ITRS)	54	49	39	36	33	27	24	0.3 x DR
Nonmetal Films (**Sc. 2.0**)	**108**	**98**	**78**	**72**	**66**	**54**	**48**	**0.6 x DR**
Bare Silicon (1999 ITRS)	54	49	39	36	33	27	24	0.3 x DR
Bare Silicon (**Sc. 2.0**)	**108**	**98**	**78**	**72**	**66**	**54**	**48**	**0.6 x DR**
Defect Review (Patterned wafer)								
Resolution (nm) *[F]	9	9	7	7	6	5	5	0.05 x DR
Coordinate Accuracy (um) at Resolution	3	3	2	2	1	1	1	*
Coordinate Accuracy (um) at Size	25	20	15	12	12	10	10	
*Automatic Defect Classification at Defect Review Platform *[G, H]*								
Redetection: minimum defect size (nm)	72	65	52	48	44	36	30	0.4 x DR
Number of defect types (1999 ITRS)	5	5	10	10	10	15	15	**
Number of defect types (**Sc. 2.0**)	**3**	**3**	**10**	**10**	**10**	**15**	**15**	**
Speed (seconds/defect)	10	10	7	5	5	5	5	
Speed - w/ elemental (seconds/defect)	25	25	20	15	13	10	10	

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node **(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 78b Technology Requriements for Defect Deteciton — Long Term**

(Node = 1/2 Dram Metal 1 Pitch)

Year *Technology Node*	*2008* *60 nm*	*2011* *40 nm*	*2014* *30 nm*	*Driver*
Patterned Wafer Inspection, PSL Spheres at 90% Capture				
Process R&D at 300 cm2/hr (1999 ITRS)	18	12	9	*0.3 x DR*
Process R&D at 300 cm2/hr - 1 W/hr (Sc. 2.0)	**36**	**24**	**18**	**0.6 x DR**
Yield Ramp at 3000 cm2/hr (1999 ITRS)	24	16	12	*0.4 xDR*
Yield Ramp at 1200 cm2/hr - 4W/hr (Sc. 2.0)	**48**	**32**	**24**	**0.8 x DR**
Volume Production at 10000 cm2/hr (1999 ITRS)	30	20	15	*0.5 x DR*
Volume Production at 3000 cm2/hr - 10W/hr (Sc. 2.0)	**60**	**40**	**30**	**1.0 x DR**
High Aspect Ratio Feature Inspection: Defects other than Residue				
All stages of manufacturing (1999 ITRS)	18	12	9	*0.3 x DR*
All stages of manufacturing (**Sc. 2.0**)	**54**	**36**	**24**	**1.0 x DR**
*Unpatterned, PSL Spheres at 90% Capture, Equivalent Sensitivity (nm) *[D, E]*				
Metal Film (1999 ITRS)	23	16	12	*0.3 x DR*
Metal Film (**Sc. 2.0**)	**46**	**32**	**23**	**0.6 x DR**
Nonmetal Films (1999 ITRS)	18	12	9	*0.3 x DR*
Nonmetal Films (**Sc. 2.0**)	**36**	**24**	**18**	**0.6 x DR**
Bare Silicon (1999 ITRS)	18	12	9	*0.3 x DR*
Bare Silicon (**Sc. 2.0**)	**36**	**24**	**18**	**0.6 x DR**
Wafer Backside	60	40	30	*1.0 x DR*
Defect Review (Patterned wafer)				
Resolution (nm) *[F]	3	2	2	*0.05 x DR*
Coordinate Accuracy (um) at Resolution	0.5	0.5	0.5	*
Coordinate Accuracy (um) at Size	**5**	**5**	**5**	
Automatic Defect Classification at Defect Review Platform				
Redetection: minimum defect size (nm)	24	16	12	*0.4 x DR*
Number of defect types (1999 ITRS)	20	20	25	**
Number of defect types (**Sc. 2.0**)	**20**	**20**	**25**	******
Speed (seconds/defect)	5	5	5	
Speed - w/ elemental (seconds/defect)	10	10	10	

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 UPDATE										
YEAR OF PRODUCTION TECHNOLOGY NODE **(1999 ITRS)**	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
YEAR OF PRODUCTION TECHNOLOGY NODE **(PROPOSED NODE YEARS ARE NOW 2007/65NM; 2010/45NM; 2013/33NM; 2016/23NM) (SC. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 NM]**	2011 **[40 NM]**	2014 **[30 NM]**

Notes for Table 78 for Defect Detection Requirements

[A] Patterned wafer scan speed is required to be at least 300 cm²/hour for process R&D mode, 3,000 cm²/hour for yield ramp mode, and at least 10,000 cm²/hour for volume production mode. Existing solutions do not achieve these targets at the above mentioned sensitivity requirement.

[B] Patterned wafer nuisance defect rate shall be lower than 15% in process R&D phase, less than 10% in yield ramp phase, and less than 5% in volume production phase.

[C] HARI defects are already considered "killers" at any process stage. Hence, minimum defect sensitivity was stipulated as 0.3 × technology node at all stages of production. Physically uninterrupted coverage of the bottom of a contact by a monolayer of material or more should also be detected.

[D] Unpatterned wafer defect detection tools will be required to scan 150 (200 mm or equivalent) wafers per hour at nuisance defect rates lower than 5%.

[E] Metal films inspection tools must detect defects greater than half the minimum contacted pitch (Interconnect chapter, Tables 46 – 48) × 0.3 (process R&D requirement for patterned wafer defects) for nongrainy films and × 0.5 for rough or grainy films. Nonmetal films and bare Si detection sensitivity must be at least as good as that for patterned wafer inspection to justify monitor wafer usage.

[F] Resolution corresponds to 10% of patterned wafer detection sensitivity for volume production.

[G] ADC: Detectability, as % of defects redetected, should be greater than 95; Accuracy, as the % of defects correctly classified as per a human expert, should be greater than 95; Repeatability should be greater than 95%; and Reproducibility, as COV%, should be no greater than 5%.

[H] Assumptions: 5,000 wafer starts per month, defects per wafer based on surface preparation at FEOL, leading to defects per hour that need review, 100% ADC.

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node (Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 79a Defect Sources and Mechanisms Technology Requirements — Near Term**

(Node = 1/2 Dram Metal 1 Pitch)

Year of Introduction "Technology Node" (1999 ITRS)	1999 180nm	2000	2001	2002 130nm	2003	2004	2005 100nm
*Year of Introduction "Technology Node" (**Sc. 2.0**)*	**1999 180nm**	2000	**2001 130nm**	**2002**	**2003**	**2004 90nm**	**2005**
Wafer size (mm)	300	300	300	300	300	300	300
Wafer area (mm2)	70714	70714	70714	70714	70714	70714	70714
Sourcing Complexity [A], [F]							
Logic transistor density/mm2 (1E4) (1999 ITRS)	7.0	9.9	14.0	17.6	22.2	30.0	40.6
Logic transistor density/mm2 (1E4) (**Sc. 2.0**)	**6.6**	**9.4**	**13.3**	**17.9**	**24.2**	**32.7**	**44.2**
Number of processing steps	380	397	413	430	447	463	480
Defect sourcing complexity factor (1E6) [B] (1999 ITRS)	27	—	—	76	—	—	195
Defect sourcing complexity factor (1E6) [B](**Sc. 2.0**)	**25**	**36**	**51**	**68**	**92**	**124**	**168**
Defect sourcing complexity trend [C] (1999 ITRS)	1	—	—	3	—	—	7
Defect sourcing complexity trend [C] (**Sc. 2.0**)	**1**	**1**	**2**	**3**	**4**	**5**	**7**
Data Analysis for Rapid Sourcing							
(#data items/wafer) (1E12) [D] (1999 ITRS)	1.9	—	—	5.4	—	—	14
(#data items/wafer) (1E12) [D] (**Sc. 2.0**)	**1.8**	**2.5**	**3.6**	**4.8**	**6.5**	**8.8**	**11.9**
Defect data volume (DV) trend [E] (1999 ITRS)	1	—	—	3	—	—	7
Defect data volume (DV) trend [E] (**Sc. 2.0**)	**1**	**1**	**2**	**3**	**4**	**5**	**7**
Time required to recognize trends (1999 ITRS)	Days	—	—	Days	—	—	Hours
Time required to recognize trends (**Sc. 2.0**)	**Days**	**—**	**Days**	**—**	**—**	**Hours**	**—**
Information sources for automatic data analysis (1999 ITRS)	Spatial	—	—	Spatial/time	—	—	Merge
Information sources for automatic data analysis (**Sc. 2.0**)	**Spatial**	**—**	**Spatial/time**	**—**	**—**	**Merge**	**—**
Transport Modeling							
Gas transport mechanism (1999 ITRS)	Transitional	Transitional	Transitional	Transitional	Transitional	Transitional	Transitional
Gas transport mechanism (**Sc. 2.0**)	**Transitional**	**Transitional**	**Transitional**	**Transitional**	**Transitional**	**Transitional**	**Transitional**
Deposition mechanism (1999 ITRS)	Assumed	Assumed	Assumed	Stick coef.	Stick coef.	Stick coef.	Stick coef.
Deposition mechanism (**Sc. 2.0**)	**Assumed**	**Assumed**	**Assumed**	**Stick coef.**	**Stick coef.**	**Stick coef.**	**Stick coef.**
Time to solve for analysis (1999 ITRS)	Hours	Hours	Hours	Minutes	Minutes	Minutes	Minutes
Time to solve for analysis (**Sc. 2.0**)	**Hours**	**Hours**	**Hours**	**Minutes**	**Minutes**	**Minutes**	**Minutes**

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2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node **(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)**	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 79b Defect Sources and Mechanisms Technology Requirements — Long Term**

(Node = 1/2 Dram Metal 1 Pitch)

Year of Introduction "Technology Node" (1999 ITRS)	2008 70nm	2011 50nm	2014 35nm
Year of Introduction "Technology Node" (**Sc. 2.0**)	**2008 60nm**	**2011 40nm**	**2014 30nm**
Wafer size (mm)	450	450	450
Wafer area (mm2)	159107	159107	159107
Sourcing Complexity [A], [F]			
Logic transistor density/mm2 (1E4)	109	269	664
Number of processing steps	530	580	630
Defect sourcing complexity factor (1E6) [B]	577.7	1560.2	4183.2
Defect sourcing complexity trend [C]	23	62	167
Data Analysis for Rapid Sourcing			
Defect data volume			
Defect data volume (#data items/wafer) (1E12) [D]	91.9	248.2	665.6
Defect data volume (DV) trend [E]	51	138	370
Time required to recognize trends	Hours	Hours	Hours
Information sources for automatic data analysis	Improve	Improve	Improve
Transport Modeling			
Gas transport mechanism	Free moleclr	Free moleclr	Free moleclr
Deposition mechanism	Mechanistic	Mechanistic	Mechanistic
Time to solve for analysis	Minutes	Minutes	Minutes

Notes for Table 79 for Defect Sources and Mechanisms Requirements

[A] Defect sourcing means identifying point of occurrence (identify process tool, design, test or process integration issue causing a visible or nondetectable defect, parametric problem or electrical fault).

[B] Defect sourcing complexity factor = (logic transistor density #/ mm^2)× (# processing steps)

[C] Defect sourcing complexity trend is normalized to 180 nm technology node.

[D] Defect data volume (DV) is the product of wafer area in mm^2 and defect sourcing complexity factor (#/mm^2).

[E] DV trend is normalized to 180 nm technology node.

[F] Rapid defect sourcing and yield learning assumptions:

- *Keep yield ramp constant at current benchmark level for successive technology nodes despite the increasing complexity and data volumes. This implies a need for increasingly sophisticated integrated yield management (IYM) tools.*
- *Keep time to source new yield detractors to ≤ 50% of theoretical cycle time.*
- *New material introduction should not increase defect sourcing time.*
- *Focus defect sourcing on ramp portion of yield learning curve.*
- *Data collection, retention and retrieval will go up exponentially and significant improvement will be required in the IYM tools to enable the above assumptions.*

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 UPDATE										
YEAR OF PRODUCTION TECHNOLOGY NODE (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
YEAR OF PRODUCTION TECHNOLOGY NODE ***(PROPOSED NODE YEARS ARE NOW 2007/65NM; 2010/45NM; 2013/33NM; 2016/23NM) (SC. 2.0)***	1999 180 nm	2000	2001 ***130 nm***	2002	2003	2004 ***90nm***	2005	2008 **[60 NM]**	2011 **[40 NM]**	2014 **[30 NM]**

*Table 80a Defects Prevention and Elimination Technology Requirements-Near Term**

Year of Introduction "Technology Node" (1999 ITRS)	1999 180nm	2000	2001	2002 130nm	2003	2004	2005 100nm
Year of Introduction "Technology Node" (***Sc. 2.0***)	1999 180nm	2000	***2001 130nm***	***2002***	***2003***	***2004 90nm***	***2005***
Wafer Environment Control							
Critical particle size (nm) [A] ***(1999 ITRS)***	90	90	75	65	60	55	50
Critical particle size (nm) [A] ***(Sc. 2.0)***	90	90	***65***	***58***	***52***	***45***	***38***
Particles ³ critical size (/m3) [B] ***(1999 ITRS)***	12	10	8	5	4	3	2
Particles ³ critical size (/m3) [B] ***(Sc. 2.0)***	12	10	***5***	***4***	***3***	***2***	2
Airborne Molecular Contaminants (pptM) [C]							
Lithography—Bases (as amine, amide, or NH3) ***(1999***	1000	1000	1000	750	750	750	750
Lithography—Bases (as amine, amide, or NH3) ***(Sc. 2.0)***	1000	1000	***750***	750	750	750	750
Gate—Metals (as Cu, E=2 × 10–5) [C] ***(1999 ITRS)***	0.3	0.3	0.25	0.2	0.2	0.15	0.1
Gate—Metals (as Cu, E=2 × 10–5) [C] ***(Sc. 2.0)***	0.3	0.3	***0.2***	0.2	***0.15***	***0.1***	0.1
Gate—Organics	200	170	130	100	90	80	70
Gate—Organics	200	170	***100***	***90***	***80***	***70***	***60***
—Organics(as CH2) ***(1999 ITRS)***	3600	3000	2400	1800	1620	1440	1260
—Organics(as CH2) ***(Sc. 2.0)***	3600	3000	***1800***	***1620***	***1440***	***1260***	***1100***
Salicidation contact—acids (as Cl–, E=1 × 10–5)	10	10	10	10	10	10	10
Salicidation contact—bases (as NH3, E=1 × 10–6) ***(1999***	40	32	24	20	16	12	10
Salicidation contact—bases (as NH3, E=1 × 10–6) ***(Sc. 2.0)***	40	32	***20***	***16***	***12***	***10***	***8***
Dopants (P or B) [F]	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Process Critical Materials							
Critical particle size (nm) [A] ***(1999 ITRS)***	90	90	75	65	60	55	50
Critical particle size (nm) [A] ***(Sc. 2.0)***	90	90	***65***	***58***	***52***	***45***	***38***
Ultrapure Water							
Total oxidizable carbon (ppb) ***(1999 ITRS)***	2	2	2	1	1	< 1	< 1
Total oxidizable carbon (ppb) ***(Sc. 2.0)***	2	2	***1***	1	***< 1***	***< 1***	***< 1***
Bacteria (CFU/ liter)	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Total Silica (ppb) ***(1999 ITRS)***	0.1	0.1	0.05	0.05	0.05	0.05	0.05
Total Silica (ppb) ***(Sc. 2.0)***	0.1	0.1	0.05	0.05	0.05	0.05	***0.01***
Dissolved oxygen (ppb) ***(1999 ITRS)***	10	7	3	1	1	1	1
Dissolved oxygen (ppb) ***(Sc. 2.0)***	10	7	***1***	***1***	***1***	***1***	***1***
Particles ³ critical size (/ml)	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Critical cation, anion, metals (ppt, each) ***(1999 ITRS)***	20	20	< 20	< 20	< 20	< 20	10
Critical cation, anion, metals (ppt, each) ***(Sc. 2.0)***	20	20	< 20	< 20	< 20	***10***	***10***

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production *Technology Node* ***(1999 ITRS)***	*1999* *180 nm*	*2000*	*2001*	*2002* *130 nm*	*2003*	*2004*	*2005* *100 nm*	*2008* *70 nm*	*2011* *50 nm*	*2014* *35 nm*
Year of Production *Technology Node* ***(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)***	*1999* *180 nm*	*2000*	*2001* ***130 nm***	*2002*	*2003*	*2004* ***90nm***	*2005*	2008 **[60 NM]**	2011 **[40 NM]**	2014 **[30 NM]**

*Table 80a Defects Prevention and Elimination Technology Requirements-Near Term (continued)**

Year of Introduction *"Technology Node" (1999 ITRS)*	*1999* *180nm*	*2000*	*2001*	*2002* *130nm*	*2003*	*2004*	*2005* *100nm*
Year of Introduction *"Technology Node" (**Sc. 2.0**)*	*1999* *180nm*	*2000*	***2001*** ***130nm***	***2002***	***2003***	***2004*** ***90nm***	***2005***
Liquid Chemicals [E]							
Particles ³ critical size (/ml)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
HF-, H2O2, NH4OH: Fe, Cu (ppt, each) ***(1999 ITRS)***	< 250	< 220	< 180	< 150	<135	< 110	< 100
HF-, H2O2, NH4OH: Fe, Cu (ppt, each) ***(Sc. 2.0)***	< 250	< 220	***< 150***	***<135***	***< 110***	***< 100***	***< 90***
Critical cation, anion, metals (ppt, each) ***(1999 ITRS)***	< 20	< 20	< 20	< 10	< 10	< 10	< 5
Critical cation, anion, metals (ppt, each) ***(Sc. 2.0)***	< 20	< 20	***< 10***	< 10	< 10	***< 5***	< 5
HF-only TOC (ppb) ***(1999 ITRS)***	< 60	< 50	< 40	< 30	< 30	< 25	< 20
HF-only TOC (ppb) ***(Sc. 2.0)***	< 60	< 50	***< 30***	< 30	***< 25***	***< 20***	***< 15***
HCl, H2SO4: All impurities (ppt)	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000
BEOL Solvents, Strippers K, Li, Na (ppt, each)	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000
Bulk Ambient Gases							
N2,O2,Ar,H2: H2O,O2,CO2,CH4 (ppt, each)	<1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000
Particles > critical size (liter)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Specialty Gases							
POU Particles ³ critical size (/liter) [D]	2	2	2	2	2	2	2
Corrosives—metal etchants							
O2 (ppbv) ***(1999 ITRS)***	< 500	< 500	< 500	< 500	< 500	< 500	< 200
O2 (ppbv) ***(Sc. 2.0)***	< 500	< 500	< 500	< 500	< 500	***< 200***	< 200
H2O (ppbv) ***(1999 ITRS)***	< 500	< 500	< 500	< 500	< 500	< 500	< 200
H2O (ppbv) ***(Sc. 2.0)***	< 500	< 500	< 500	< 500	< 500	***< 200***	< 200
Inerts—Oxide/PR Etchants/Strippers							
O2 (ppbv) ***(1999 ITRS)***	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 500
O2 (ppbv) ***(Sc. 2.0)***	< 1000	< 1000	< 1000	< 1000	< 1000	***< 500***	< 500
H2O (ppbv) ***(1999 ITRS)***	< 1000	< 1000	< 1000	< 1000	< 1000	< 1000	< 500
H2O (ppbv) ***(Sc. 2.0)***	< 1000	< 1000	< 1000	< 1000	< 1000	***< 500***	< 500
Total metallics (pptwt)	< 500	< 500	< 500	< 500	< 500	< 500	< 500

** In response to the observed acceleration of the Technology Nodes (TN) represented by DRAM half-pitch, the IRC proposes a new TN called Scenario 2 (SC. 2.0) for the year 2001 Renewal. The subsequent contents of this Table have been tied to update so as to reflect the new TN.*

All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node (Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)	1999 180 nm	2000	2001 **130 nm**	2002	2003	2004 **90nm**	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 80b Defects Prevention and Elimination Technology Requirements–Long Term**

Year of Introduction "Technology Node" (1999 ITRS)	2008 70nm	2011 50nm	2014 35nm
Year of Introduction "Technology Node" (**Sc. 2.0**)	**2008** **60nm**	**2011** **40nm**	**2014** **30nm**
Wafer Environment Control			
Critical particle size (nm) [A] ***(1999 ITRS)***	35	25	18
Critical particle size (nm) [A] ***(Sc. 2.0)***	***30***	***20***	***15***
Particles ³ critical size (/m3) [B] ***(1999 ITRS)***	1	1	1
Particles ³ critical size (/m3) [B] ***(Sc. 2.0)***	1	1	***<1***
Airborne Molecular Contaminants (pptM) [C]			
Lithography—Bases (as amine, amide, or NH3) ***(1999 ITRS)***	< 750	< 750	< 750
Lithography—Bases (as amine, amide, or NH3) ***(Sc. 2.0)***	< 750	< 750	< 750
Gate—Metals (as Cu, E=2 × 10–5) [C] ***(1999 ITRS)***	0.07	< 0.07	< 0.07
Gate—Metals (as Cu, E=2 × 10–5) [C] ***(Sc. 2.0)***	0.07	< 0.07	< 0.07
Gate—Organics	70	50	< 50
Gate—Organics	***50***	***40***	***<40***
—Organics(as CH2) ***(1999 ITRS)***	1260	900	< 900
—Organics(as CH2) ***(Sc. 2.0)***	***900***	***< 900***	< 900
Salicidation contact—acids (as Cl–, E=1 × 10–5)	10	10	10
Salicidation contact—bases (as NH3, E=1 × 10–6) ***(1999 ITRS)***	4	< 4	< 4
Salicidation contact—bases (as NH3, E=1 × 10–6) ***(Sc. 2.0)***	***< 4***	< 4	< 4
Dopants (P or B) [F]	< 10	< 10	< 10
Process Critical Materials			
Critical particle size (nm) [A] ***(1999 ITRS)***	35	25	18
Critical particle size (nm) [A] ***(Sc. 2.0)***	***30***	***20***	***15***
Ultrapure Water			
Total oxidizable carbon (ppb) ***(1999 ITRS)***	< 1	< 1	< 1
Total oxidizable carbon (ppb) ***(Sc. 2.0)***	< 1	< 1	< 1
Bacteria (CFU/ liter)	< 1	< 1	< 1
Total Silica (ppb) ***(1999 ITRS)***	0.01	0.01	0.01
Total Silica (ppb) ***(Sc. 2.0)***	0.01	0.01	***<0.01***
Dissolved oxygen (ppb) ***(1999 ITRS)***	1	1	1
Dissolved oxygen (ppb) ***(Sc. 2.0)***	1	1	***<1***
Particles ³ critical size (/ml)	< 0.2	< 0.2	< 0.2
Critical cation, anion, metals (ppt, each) ***(1999 ITRS)***	1	1	1
Critical cation, anion, metals (ppt, each) ***(Sc. 2.0)***	1	1	***<1***

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production Technology Node (1999 ITRS)	1999 180 nm	2000	2001	2002 130 nm	2003	2004	2005 100 nm	2008 70 nm	2011 50 nm	2014 35 nm
Year of Production Technology Node ***(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)***	1999 180 nm	2000	2001 ***130 nm***	2002	2003	2004 ***90nm***	2005	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

*Table 80b Defects Prevention and Elimination Technology Requirements–Long Term (coninued)**

Year of Introduction "Technology Node" (1999 ITRS)	2008 70nm	2011 50nm	2014 35nm
Year of Introduction "Technology Node" (***Sc. 2.0***)	***2008 60nm***	***2011 40nm***	***2014 30nm***
Liquid Chemicals [E]			
Particles ³ critical size (/ml)			
HF-, H2O2, NH4OH: Fe, Cu (ppt, each) ***(1999 ITRS)***	< 0.5	< 0.5	< 0.5
HF-, H2O2, NH4OH: Fe, Cu (ppt, each) ***(Sc. 2.0)***	***< 50***	***< 50***	***< 40***
Critical cation, anion, metals (ppt, each) ***(1999 ITRS)***	< 1	< 1	< 1
Critical cation, anion, metals (ppt, each) ***(Sc. 2.0)***	< 1	< 1	< 1
HF-only TOC (ppb) ***(1999 ITRS)***	< 15	< 10	< 10
HF-only TOC (ppb) ***(Sc. 2.0)***	***< 10***	***<8***	***<5***
HCl, H2SO4: All impurities (ppt)	< 1000	< 1000	< 1000
BEOL Solvents, Strippers K, Li, Na (ppt, each)	< 1000	< 1000	< 1000
Bulk Ambient Gases			
N2,O2,Ar,H2: H2O,O2,CO2,CH4 (ppt, each)	< 100	< 100	< 100
Particles > critical size (liter)	< 0.1	< 0.1	< 0.1
Specialty Gases			
POU Particles ³ critical size (/liter) [D]	2	2	2
Corrosives—metal etchants			
O2 (ppbv) ***(1999 ITRS)***	< 200	< 50	< 50
O2 (ppbv) ***(Sc. 2.0)***	***< 100***	< 50	< 50
H2O (ppbv) ***(1999 ITRS)***	< 200	< 50	< 50
H2O (ppbv) ***(Sc. 2.0)***	***< 100***	< 50	< 50
Inerts—Oxide/PR Etchants/Strippers			
O2 (ppbv) ***(1999 ITRS)***	< 500	< 100	< 100
O2 (ppbv) ***(Sc. 2.0)***	< 500	< 100	< 100
H2O (ppbv) ***(1999 ITRS)***	< 500	< 100	< 100
H2O (ppbv) ***(Sc. 2.0)***	< 500	< 100	< 100
Total metallics (pptwt)	< 100	< 100	< 100

Notes for Table 80a and b for Defect Prevention and Elimination Requirements

[A] Critical particle size is based on ½ design rule. All defect densities are "normalized" to critical particle size. Critical particle size does not necessarily mean "killer."

[B] Airborne particle requirements are based on an assumed value for deposition velocity of 0.01 cm/second, resulting in 1 particle/m^2/hr. for a ambient concentration of 3 particles/m^3. (This value represents an approximate value at atmospheric conditions. As an example, the 180 nm requirement is calculated as:
(13 particles/m^2/step) × (300 steps)/1000 hrs) × (3 particles/ m^3/1 particle/m^2/hr =12 particles / m^3.

[C] Ion indicated is basis for calculation. Exposure time is 60 minutes with starting surface concentration of zero. Basis for lithography is defined by lithography roadmap. Gate metals and organics scale as surface preparation roadmap metallics and organics All airborne

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.

2000 Update										
Year of Production *Technology Node* **(1999 ITRS)**	*1999* *180 nm*	*2000*	*2001*	*2002* *130 nm*	*2003*	*2004*	*2005* *100 nm*	*2008* *70 nm*	*2011* *50 nm*	*2014* *35 nm*
Year of Production *Technology Node* ***(Proposed node years are now 2007/65nm; 2010/45nm; 2013/33nm; 2016/23nm) (Sc. 2.0)***	*1999* *180 nm*	*2000*	*2001* ***130 nm***	*2002*	*2003*	*2004* ***90nm***	*2005*	2008 **[60 nm]**	2011 **[40 nm]**	2014 **[30 nm]**

molecular contaminants calculated as S=E(N*V/4); where S is the arrival rate (molecules/second/cm²), E is the sticking coefficient (between 0 and 1, N is the concentration in air (molecules/cm³); and V is the average thermal velocity (cm/second)*

[D] *The sticking coefficients for organics vary greatly with molecular structure and are also dependent on surface termination. In general molecular weights < 250 not considered detrimental due to the higher volatility of these compounds.*

[E] *Particle targets apply at POU, not incoming chemical. Point-of-tool connection chemical metallic targets are based on Epi starting material, sub-ppb contribution from bulk distribution system, 1:1:5 standard clean 1 (SC-1) and elevated temperature 1:1:5 standard clean 2 (SC-2) final clean step. "HF last" or "APM last" cleans would require ~10× and ~100× improved purity HF (mostly Cu) and APM chemicals, respectively.*

[F] *Includes P, B, As, Sb*

[G] *Critical metals and ions include: Ca, Co, Cu, Cr, Fe, Mo, Mn, Na, Ni, W*

[H] *TOC values are based on best available technology and are not necessarily supported by yield data.*

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All the items and/or numericals modified from the 1999 ITRS are highlighted in bold blue text.