

File SFTOC.DOC contains the following bookmarks. Select the topic you are trying to find from the list and double click the highlighted text.

<a href="#">CustomDictionaryForWord</a>	<a href="#">DocumentationFileList</a>
<a href="#">GettingStarted</a>	<a href="#">MarginRecommendation</a>
<a href="#">NavigationTips</a>	<a href="#">PrintingTheDocumentation</a>
<a href="#">PrintingHighlightedMaterial</a>	<a href="#">PrintingOnA4Paper</a>
<a href="#">PrintingRangeOfPages</a>	<a href="#">PrintingTheCurrentPage</a>
<a href="#">PrintingTheEntireDocument</a>	<a href="#">TemplateFileForWord</a>
<a href="#">UsingTheEditGoToMenu</a>	<a href="#">UsingTheHypertextLinks</a>
<a href="#">UpdatingTheTableOfContents</a>	<a href="#">WordSettings</a>
<a href="#">WordViewerSettings</a>	

Quick links to other files:

<a href="#">SFINTRO.DOC</a>	Introduction, problem variables, SF.INI settings, technical support
<a href="#">SFFILES.DOC</a>	Descriptions of input and output files
<a href="#">SFCODES.DOC</a>	Autofish, Automesh, Fish, CFish, Poisson, Pandira
<a href="#">SFPOSTP.DOC</a>	WSFplot, SFO, SF7, Force
<a href="#">SFCODES2.DOC</a>	Cavity tuning programs XXXfish (CCLfish, DTLfish, etc.)
<a href="#">SFCODES3.DOC</a>	Plotting programs Quikplot, Tablplot, and utility programs
<a href="#">SFEXMPL1.DOC</a>	Example files for Fish, CFish, and Autofish
<a href="#">SFEXMPL2.DOC</a>	Example files for Poisson and Pandira
<a href="#">SFEXMPL3.DOC</a>	Example files for tuning programs
<a href="#">SFPHYS1.DOC</a>	Theory of electrostatics and magnetostatics
<a href="#">SFPHYS2.DOC</a>	Properties of static magnetic and electric fields
<a href="#">SFPHYS3.DOC</a>	Boundary conditions and symmetries
<a href="#">SFPHYS4.DOC</a>	Numerical methods in Poisson and Pandira
<a href="#">SFPHYS5.DOC</a>	RF cavity theory



**LA-UR-96-1834**

**Revised January 13, 2006**

# **Poisson Superfish**

**James H. Billen and Lloyd M. Young**

**Documentation by  
James H. Billen**

**Los Alamos**  
National Laboratory



# **Poisson Superfish**

**LA-UR-96-1834**

## **Copyright and disclaimer**

**Copyright, 1985-2006, The Regents of the University of California.**

**This software was produced under U.S. Government contract W-7405-ENG-36 by Los Alamos National Laboratory, which is operated by the University of California for the U.S. Department of Energy. Neither the Government nor the University makes any warranty, express or implied, or assumes any liability or responsibility for the use of this software.**

## **Acknowledgments**

The authors of this version of Poisson Superfish wish to acknowledge the extremely important contributions of Ronald Holsinger and Klaus Halbach, who wrote the original version of these codes in the late 1960s and early 1970s. In addition, the authors have benefited from the work of several LAACG members who have since retired from Los Alamos National Laboratory, including Richard K. Cooper (former Code Group leader), Mary T. Menzel, Grenfell Boicourt, Therese Barts, Jean Merson, Gary Rodenz, and John L. Warren. John Warren led the earlier documentation effort that resulted in two volumes published in 1987. Several chapters related to the physics in the codes from John Warren's treatment have been reproduced in this document. The authors thank the many users of these codes who have pointed out bugs and made suggestions for additional features in this version. The authors are especially grateful to Richard K. Cooper for his very careful proofreading of this documentation.

This documentation was produced by the Los Alamos Accelerator Code Group (LAACG) at Los Alamos National Laboratory. The activities of the LAACG are supported by the US Department of Energy, Office of Energy Research, through the Division of High Energy Physics, Division of Nuclear Physics, and Division of Mathematics, Information, and Computational Sciences.

Original release: January 10, 1996  
Revision date (version 7.17): January 13, 2006



# Table of Contents

<b>I. How To Use This Document</b>	<b>1</b>
<b>A. Getting started</b>	<b>1</b>
<b>B. List of the documentation files</b>	<b>1</b>
<b>C. Suggestions for viewing the documentation</b>	<b>2</b>
1. Microsoft Word template and dictionary files	3
2. Settings in Microsoft Word	3
3. Settings in Microsoft Word Viewer	3
4. Using the table of contents	4
5. Using the hypertext links	4
6. Using the Edit, Go To... menu	4
<b>D. Printing sections of this documentation</b>	<b>5</b>
1. Printing the entire document	5
a. Margin settings	5
b. Printing on A4 paper	6
2. Printing the current page	6
3. Printing a range of pages	6
4. Printing highlighted material	6
<b>E. Updating the table of contents</b>	<b>6</b>
<b>II. Poisson Superfish software installation</b>	<b>9</b>
<b>A. Machine requirements</b>	<b>9</b>
1. Performance issues	9
<b>B. Installation directory and subdirectories</b>	<b>10</b>
1. Subdirectory LANL\Docs, documentation files	10
2. Subdirectory LANL\Examples, sample input files	10
3. Subdirectory LANL\DeveloperFiles, files for code developers	11
<b>C. Other files in the LANL directory</b>	<b>11</b>
<b>D. The Lahey/Fujitsu Fortran compiler and <i>Winteracter</i> library</b>	<b>12</b>
<b>E. Technical support and code updates</b>	<b>12</b>
1. Electronic mail support address: Superfish@lanl.gov	13
2. Email discussion group	13
3. Obtaining updated installation files	13
4. Email notification of new features and bug fixes	14
<b>F. Files provided for program developers</b>	<b>14</b>
1. Using the dynamic link library	15
a. Function INTERP	17
b. Functions I_Variable and R_Variable	17
c. Function GetTitle	18
d. Multiple DLLs	18
e. Example files	19
2. Calling Fortran LF95 library routines	20

a. Batch files for running the sample programs	20
b. LF95.Fig, configuration file	21
c. INCLUDE file T35ARRAY.INC	21
d. Fortran modules	21
e. RDTape35 and RDRECORD1, subroutines for reading solution files	32
f. Interpolate, subroutine for interpolating fields	36
<b>III. Introduction to Poisson Superfish</b>	<b>44</b>
<b>A. History of the development of Poisson Superfish</b>	<b>45</b>
1. Code development under LAACG	45
2. Features added in version 5	46
a. User interface improvements	47
b. Automesh improvements	48
c. RF solver improvements	49
d. New field interpolator	51
e. Memory management and program limits	52
f. Postprocessor improvements	53
g. New programs	54
3. Features added in version 6	55
a. Source code organization	55
b. Installation program	56
c. Program WSFplot	56
d. Programs Quikplot and Tablplot	56
e. Unlimited number of material tables and error checking of material data	56
f. Force code improvements	57
g. Field interpolator improvements	57
h. Program MK_SFINI	58
i. Tuning-code companion programs	58
4. Features added in version 7	58
a. Conversion of binary solution files to version 7 format	58
b. Automesh improvements	58
c. Larger problems supported	59
d. Numbered warning messages	59
e. Dynamic link library containing the field interpolator	59
<b>B. References</b>	<b>59</b>
1. Published references to Poisson Superfish	59
2. Other references	60
<b>C. Terminology</b>	<b>61</b>
1. Superfish codes	61
2. Solver program	61
3. Tuning program	61
4. Superfish problem or Poisson problem	61
5. Postprocessor	62
6. Plotting program	62
7. SOR	62
8. Binary solution file	62
9. Configuration file or initialization file	62
10. Boundary conditions	62
11. Beta, the symbol $\beta$	63
12. Beta-lambda, the product $\beta\lambda$	63
13. Cavity	63



14. CCDTL	63
15. CCL	63
16. Cell	63
17. Coupling	64
18. Coupling cell or coupling cavity	64
19. DTL	64
20. Gamma, the symbol $\gamma$	64
21. Gap	64
22. Geometric $\beta$	64
23. Graded $\beta$	65
24. Kilpatrick field	65
25. Modes	65
a. Cavity modes	65
b. Structure modes	66
26. Post coupler	66
27. Quality factor Q	66
28. RFQ	66
29. Shunt impedance	66
30. Skin depth	67
31. Transit-time factor	67
<b>D. Summary of the Poisson Superfish codes</b>	<b>68</b>
1. Autofish	69
2. Automesh	69
3. Lattice	69
4. Fish	69
5. CFish	69
6. Poisson	70
7. Pandira	70
8. WSFplot	70
9. SFO	70
10. SF7	71
11. Force	71
12. DTLfish	71
13. DTLCells	72
14. CCLfish	72
15. CCLCells	72
16. CDTfish	72
17. ELLfish	72
18. ELLCAV	73
19. MDTfish	73
20. MDTCells	73
21. RFQfish	73
22. SCCfish	73
23. Quikplot	73
24. Tablplot	74
25. List35	74
26. SFOtable	74
27. SegField	74
28. Beta	74

29. Kilpat	74
30. ConvertF	74
31. FScale	74
32. SF8	75
33. MK_SFINI	75
<b>E. Problem variables</b>	<b>76</b>
1. Problem variables for Fish and CFish	76
2. Problem variables for Poisson and Pandira	79
<b>F. Configuring Poisson Superfish features: SF.INI</b>	<b>83</b>
1. InternalArrays setting	86
2. Saving file TAPE36	86
3. Drives for scratch files and storing scratch data in memory	86
4. Limiting memory available to certain programs	87
5. Forcing programs to always browse for an input file	88
6. Setting the binary solution file extension	88
7. Turning on and off selected warning messages	88
8. Setting the hardcopy graphics type	92
9. Setting initial display preferences for WSFplot	93
10. Setting the interval between contour lines in WSFplot	93
11. Saving the WSFplot field contours	95
12. Choosing the plotting code preference file	95
13. Configuring program Quikplot and Tablplot	95
14. Setting the filename length for SF7 output files	96
15. Setting precision of field data printed in output text files	96
16. Including field-interpolator fitting data with SF7 results	97
17. Configuring SF7 to write real and imaginary CFish fields	97
18. Setting default values for the SF7 dialog window	97
19. Controlling field normalization in SF7 when generating Parmela data	98
20. Controlling some behavior of the field interpolator	98
21. Setting initial display preferences for Beta utility	100
22. Writing the file FishScan.TBL in Fish or CFish	100
23. Create file CircleFit.QKP during CFish resonance	101
24. Writing Poisson or Pandira field data for program Parmela	101
25. Writing permeability tables in Poisson and Pandira	102
26. Calculating stored energy in Poisson and Pandira	102
27. Configuring particle velocity settings for SFO and tuning programs	102
28. Calculating fields on Dirichlet boundaries in SFO	103
29. Writing transit-time data for Parmila in SFO	103
30. Saving the binary solution files during tuning program sessions	104
31. Setting the preferred normalization method in tuning codes	104
32. Making CDTfish compute transit-time factors at the geometric center	105
33. Setting a maximum tuning-ring thickness in CCLfish and CDTfish	105
34. Deleting or saving no-ring Superfish files in CCLfish and CDTfish	106
35. Controlling line regions through the drift tube in DTLfish and MDTfish	106
36. Computing Slater-Perturbation Frequency Shifts in WSFplot and SF7	106
<b>G. Precision of variables in Poisson Superfish</b>	<b>107</b>
<b>H. Field interpolation from the solution arrays</b>	<b>108</b>

1. Problems with Cartesian (XY) coordinates use functions 17 to 25	111
a. Function 17: general function for interior non-boundary points	111
b. Function 18: vertical Neumann boundary	111
c. Function 19: horizontal Neumann boundary	111
d. Function 20: vertical Neumann and horizontal Neumann boundaries	111
e. Function 21: vertical Dirichlet and horizontal Dirichlet boundaries.	111
f. Function 22: vertical Dirichlet boundary	112
g. Function 23: horizontal Dirichlet boundary	112
h. Function 24: vertical Neumann and horizontal Dirichlet boundaries	112
i. Function 25: vertical Dirichlet and horizontal Neumann boundaries	112
2. Electrostatic problems with cylindrical symmetry use functions 27 to 29	112
a. Function 27: general function for interior non-boundary points	113
b. Function 28: horizontal Dirichlet boundary	113
c. Function 29: horizontal Neumann boundary	113
3. Magnetostatic problems with cylindrical coordinates use functions 37 to 39	113
a. Function 37: interior non-boundary points	114
b. Function 38: horizontal Dirichlet boundary	114
c. Function 39: horizontal Neumann boundary	114
4. RF problems with cylindrical coordinates use functions 57 to 68	114
a. Function 57: general function for interior non-boundary points	114
b. Function 58: horizontal Neumann boundary	115
c. Function 59: vertical Neumann boundary	115
d. Function 60: horizontal Neumann and vertical Neumann boundaries	115
e. Function 61: horizontal Dirichlet and vertical Dirichlet boundaries	115
f. Function 62: horizontal Dirichlet boundary at nonzero R	115
g. Function 63: vertical Dirichlet boundary	115
h. Function 64: horizontal Neumann and vertical Dirichlet boundaries	115
i. Function 65: horizontal Dirichlet and vertical Neumann boundaries	116
j. Function 66: near $R = 0$ and no other boundaries	116
k. Function 67: near $R = 0$ and a vertical Neumann boundary	116
l. Function 68: near $R = 0$ and a vertical Dirichlet boundary	116
<b>I. Poisson Superfish program limits</b>	<b>116</b>
<b>J. Temporary data arrays used by Fish, CFish, and Pandira</b>	<b>117</b>
1. Using a scratch file	118
2. Forcing the codes to use a scratch file instead of memory	118
3. Deleting unerased scratch files	118
<b>I. Files and Filename Conventions</b>	<b>121</b>
<b>A. Introduction</b>	<b>121</b>
1. Summary of the input and output files	121
2. Naming files	122
3. Registered file types and right-button menus	123
4. Opening input files on startup	124
a. Starting with an input filename	125
b. Starting with more than one input filename	125
c. Starting without an input filename	126
5. Using comments to document input files	128
6. A word about text editors and output-file fonts	128
<b>B. Automesh input file</b>	<b>128</b>
<b>C. Other input files</b>	<b>129</b>

1. T36 file, modifying the Automesh-generated boundaries	129
2. SEG file, input file for program SFO	130
3. IN7, input file for program SF7	130
4. <i>CurveFile</i> , an input file for program SF7	130
5. FCE file, input file for Force	131
<b>D. Files for sharing data among codes</b>	<b>131</b>
1. The Poisson Superfish binary solution file	131
2. TAPE36, boundary-point data file	132
3. TAPE37, temporary Automesh file	132
<b>E. Poisson Superfish output text files</b>	<b>133</b>
1. OUTAUT.TXT, the Automesh output file	133
2. OUTFIS.TXT, the Fish and CFish output file	133
3. OUTPOL.TXT and OUTPAN.TXT, Poisson and Pandira output files	133
4. OUTFOR.TXT, the Force output file	134
5. SFO output file	134
6. OUTSF7.TXT, the SF7 output file	135
7. OUTWSF.TXT, the WSFplot output file	135
<b>F. Hard copy graphics files</b>	<b>135</b>
<b>G. Input files for plotting programs</b>	<b>135</b>
1. OUTPOL.TBL and OUTPAN.TBL, Tablplot files of interpolated fields	135
2. FishScan.TBL, Fish and CFish frequency-scan output file	135
3. Transit.TBL, transit-time data versus longitudinal position	137
4. TBeta.TBL, transit-time data versus particle velocity	138
5. Plot files created by SF7	138
6. Files that store current screen settings	139
<b>H. Files for other programs</b>	<b>139</b>
1. Data files for program Parmela	139
a. SF7-interpolated fields for Parmela	140
b. Poisson- and Pandira-interpolated fields for Parmela	141
2. Input file for the electron-gun code EGUN	141
3. PMI file, transit-time data for program Parmela	142
a. Example PMI file for a DTL half cell	144
b. Example PMI file for a 3-gap CCDTL	144
<b>I. Sample batch command files</b>	<b>145</b>
<b>V. Autofish: Combined Automesh, Fish, and SFO</b>	<b>147</b>
<b>VI. Automesh: the Poisson Superfish Mesh Generator</b>	<b>148</b>
<b>A. Starting program Automesh</b>	<b>148</b>
1. Using the Esc key to stop Automesh early	148
<b>B. Automesh files and filename conventions</b>	<b>149</b>
<b>C. Input file of namelist variables</b>	<b>149</b>
1. REG namelist: Input of region data and problem parameters	153
a. Variables that can only appear in the first REG namelist	153
b. Entry of line-region array variables	153
c. Default values for the mesh increments DX and DY	154

d. Variables that can appear in the first and any other REG namelist	155
e. Material numbers	155
f. The MODE setting for declaring material properties	155
2. PO namelist: Input of boundary-point data in Automesh	156
a. Problem boundaries, requirements for region 1	157
b. Straight line segments	157
c. Circular and elliptical arc segments	157
d. Hyperbolic segments	158
e. Obsolete PO namelist variable NEW	158
3. MT namelist: Input of material data in Automesh	158
a. Material data for rf problems	161
b. Material data for electrostatic problems	162
c. Isotropic magnetic materials	163
d. Anisotropic and permanent-magnet materials	165
e. Anisotropic material with variable easy axis direction	167
f. Permanent magnets and real currents	167
4. POA namelist: Input of single-point boundary values	168
<b>D. Sample Automesh input files</b>	<b>169</b>
1. Superfish pillbox cavity	169
2. Example with an elliptical segment	170
3. Poisson and Pandira H-shaped magnet	170
<b>E. Solving for rf and electrostatic fields in the same geometry</b>	<b>171</b>
<b>F. Entering coordinate data in units other than centimeters</b>	<b>172</b>
<b>G. Specifying boundary conditions and fixed potentials</b>	<b>174</b>
1. Boundary conditions at the edges of the problem geometry	174
2. Using IBOUND to indicate boundary conditions	174
3. Using IBOUND to indicate fixed-potential values	175
4. Using the POA namelist to indicate a single-point fixed-potential	175
5. Simulating a floating electrode	175
<b>H. Specifying rectangular or cylindrical coordinate systems</b>	<b>175</b>
<b>I. Complementary solutions for rf cavities</b>	<b>175</b>
<b>J. SF.INI settings for Automesh</b>	<b>178</b>
<b>K. Mesh optimization considerations</b>	<b>178</b>
1. Using line regions to control the mesh size in Automesh	178
2. Choosing the mesh size	180
3. Other tips related to meshing the problem	181
4. Mesh modification option	181
<b>L. Drive points for Superfish problems</b>	<b>183</b>
1. Specifying a single drive point	183
2. Line drives for CFish problems	184
3. Wavelength and starting phase for a sinusoidal drive line	184
<b>M. Overlapping and adjacent regions</b>	<b>184</b>
<b>N. Indicating the triangle type used to fill the mesh</b>	<b>185</b>
1. Bad triangles: overlapping, zero-area, and near zero-area triangles	186
a. Fatal errors, overlapping triangles or zero-area triangles	186

b. Nonfatal errors, near zero-area triangles	186
<b>O. Indicating the cavity type for program Parmila</b>	<b>187</b>
<b>P. Controlling the relaxation order for the mesh points</b>	<b>188</b>
<b>Q. How Automesh initializes the potential</b>	<b>188</b>
<b>R. Variables calculated by Automesh</b>	<b>190</b>
1. NREG and MAXPPR, number of regions and maximum points per region	190
2. XMING, XMAXG, YMING, and YMAXG, the problem boundaries	190
3. KMAX and LMAX, the number of mesh intervals along each coordinate	190
4. ITOT, the total number of mesh points in the problem	191
5. DX1, the X mesh interval in the first region	191
6. DXMIN and DYMIN, the smallest mesh intervals	191
7. XDRI, YDRI, the drive-point location for Superfish problems	191
8. XBZERO, YBZERO, physical point where $B = B_{DES}$ in Poisson	191
9. KBZERO, LBZERO, logical point where $B = B_{DES}$ in Poisson	192
10. IPERM, indicates if a Pandira problem includes real currents	192
11. NSEG, the number of boundary segments	192
12. NPBOUND, the number of points along all boundary segments	192
13. NAIR, the number of mesh points in empty space	192
14. NFE, the number of mesh points in iron	192
15. NINTER, the number of mesh points on an interface	192
16. NBND, the number of mesh points on Dirichlet boundaries	192
17. NSPL, the number of mesh points with user-defined fixed-potential	192
18. NPINP, the number of mesh points in the problem	193
19. NWMAX, the number of points for recalculating couplings	193
20. NGMAX and NGSAM, coupling array counters	193
21. NPONTS, the number of unknown relaxation points	193
22. LCYCLE, the number of relaxation iterations	193
23. CLIGHT and PI, the speed of light and the number $\pi$	193
24. EPS0 and FMU0, permittivity and permeability of free space	194
25. SPOSG, SNEGG, STOTG, currents at generation for magnet problems	194
26. XYAREA and VOLUME, area and volume in the problem geometry	194
27. TRIMIN, TRIMAX, and TRIAVG, size of mesh triangles	194
<b>S. Automesh error messages</b>	<b>194</b>
<b>VII. Fish and CFish, Radio-Frequency Field Solvers</b>	<b>200</b>
<b>A. Starting and stopping Fish and CFish</b>	<b>200</b>
1. Using the Esc key to stop Fish or CFish early	200
<b>B. Fish and CFish files and filename conventions</b>	<b>201</b>
<b>C. Data entries for Fish and CFish</b>	<b>201</b>
1. Controlling pivoting in matrix inversion routines	201
2. Setting up a frequency scan	202
<b>D. The Superfish root finder</b>	<b>202</b>
1. Root finder in program Fish	203
2. Root finder in tuning programs	204
3. Root finder in program CFish	205

<b>E. Convergence criteria in the Fish and CFish solvers</b>	<b>206</b>
<b>F. Variables calculated by Fish and CFish</b>	<b>207</b>
1. DSLOPE, the slope of the $D(k^2)$ function	207
2. FREQ, the resonant frequency	208
3. XK0 and XKSQ, the wave number $k$ and its square $k^2$	208
4. DKSQ, the proposed change in $k^2$ at the last iteration	208
5. ERG, the Fish and CFish stored-energy integral	208
6. RESIDA, the residual of the solution matrix	209
7. RESIK, the ratio $ D(k^2) /k^2$ at the end of the last iteration	209
8. ICYCLE, the number of the last completed iteration	209
9. Q2I, the ratio $1/2Q$ calculated by CFish for lossy materials	209
<b>G. Fish and CFish exit error codes</b>	<b>209</b>
<b>VIII. Poisson and Pandira, Static Field Solvers</b>	<b>211</b>
<b>A. Starting and stopping Poisson and Pandira</b>	<b>211</b>
1. Using the Esc key to stop Poisson or Pandira early	211
<b>B. Files and filename conventions</b>	<b>211</b>
<b>C. Data entries for Poisson and Pandira</b>	<b>212</b>
<b>D. Input options for Poisson and Pandira</b>	<b>213</b>
1. Permeability tables	214
2. Listing the fast-interpolation material tables	216
3. Using the stacking-factor correction	216
4. Adjusting fields for a particular value on a mesh point	218
5. Computing a series of solutions for a range of current multipliers	219
6. Some properties of permanent-magnet materials	220
7. Initialization for permanent-magnet problems	222
8. Controlling pivoting in Pandira matrix inversion routines	222
9. Mesh-point initialization in coil regions	222
10. $H \cdot dl$ integrals during the Poisson calculation	223
11. Electrostatic fields	223
<b>E. Output options in Poisson and Pandira</b>	<b>224</b>
1. Defining boundaries for computing the field and gradient	224
2. Harmonic analysis of the field's multipole content	226
a. Mathematical theory of harmonic analysis	226
b. Implementing the harmonic analysis	229
3. Conformal transformations	231
4. Stored energy calculations in Poisson and Pandira	232
<b>F. Convergence in the Poisson and Pandira solvers</b>	<b>233</b>
<b>G. Quantities calculated by Poisson and Pandira</b>	<b>237</b>
1. SPOSA, SNEGA, and STOTA, currents after completing the solution	237
2. XJFACT, factor by which currents have been scaled	237
3. RATIO, the quantity $ BZERO /XJFACT$	238
4. SNOLDA and SNOLDI, old values of the summed squares of the residuals	238
5. RHOAIR, optimized over-relaxation parameter	238
6. ENERGY, computed stored energy	238

7. RESIDA and RESIDI, the residuals for air and iron points	239
8. ICYCLE, the number of the last completed iteration	239
9. ETAAIR and ETAFE, rates of convergence parameters	239
<b>H. Poisson and Pandira error messages</b>	<b>240</b>
<b>IX. WSFplot: the Poisson Superfish Plotting Code</b>	<b>241</b>
<b>A. Starting program WSFplot</b>	<b>241</b>
<b>B. WSFplot display windows</b>	<b>242</b>
1. Main display window	242
a. Zoom levels	243
b. Plot title, file ID footer, and numbered axes	243
c. Boundary segments	244
d. Mesh triangles	244
e. Contour lines	244
f. Field arrows	246
g. Field circles	246
h. Display orientation	246
i. Color settings	247
j. Line widths	247
2. Field-display window	248
a. Field components for magnetic-field problems	248
b. Field components for electric-field problems	249
c. Field components for rf problems with real fields	249
d. Field components and power losses for rf problems with complex fields	249
<b>C. Output from WSFplot</b>	<b>250</b>
1. Writing contour coordinates to OUTWSF.TXT	250
2. Hardcopy of graphics screens	251
a. BMP (Windows Bitmap Format)	251
b. CGM (Computer Graphics Metafile)	252
c. DXF (AutoCAD Drawing Exchange Format)	252
d. PS (PostScript) and EPS (Encapsulated PostScript)	252
e. HP-GL and HP-GL/2 (Hewlett Packard Graphics Language)	252
f. PCX (ZSoft PC Paintbrush Format)	253
g. PNG (Portable Network Graphics)	253
h. SVG (Scalable Vector Graphics)	253
i. WMF (Windows Metafile) and EMF (Enhanced Windows Metafile)	253
3. WSFplot preference file	254
<b>D. WSFplot error messages</b>	<b>255</b>
<b>X. SFO: Poisson Superfish Postprocessor</b>	<b>256</b>
<b>A. Starting program SFO</b>	<b>256</b>
<b>B. SFO files and filename conventions</b>	<b>257</b>
<b>C. Problem variables for SFO</b>	<b>257</b>
1. Static-field solvers Poisson and Pandira use the FieldSegments table	259
2. Running SFO more than once on the same problem	259
<b>D. Field normalization in SFO</b>	<b>260</b>
1. Using the NORM=0 option: normalize to $E_0$	261



2. Using the NORM=1 option: normalize to $E_0T$	261
3. Using the NORM=2 option: normalize to a value of $H_\phi$	261
4. Using the NORM=3 option: use default or user-supplied ASCALE	262
5. Using the NORM=4 option: normalize to a field integral between points	262
6. Off-axis integration of $E_z$	262
<b>E. Options for calculating surface resistance</b>	<b>262</b>
1. Surface resistance for normal conductors	263
2. Surface resistance for superconductors	264
3. Entering a known surface resistance	264
4. Entering a known value for the bulk resistivity	265
5. Entering surface resistance data for individual segments	265
6. Resistivity of common metals and brazing alloys	266
<b>F. Power calculations in SFO</b>	<b>268</b>
1. Power calculations on boundary segments	268
a. Segment numbering	268
b. Power and rf fields on Dirichlet boundaries	268
c. Complementary solutions	269
2. Power estimates on stems	269
a. Negative segment numbers indicate a stem	269
b. Stems in multiple-cell problems	270
c. Stem proximity effect	270
3. Total surface area used for power calculations	271
4. Coupling-slot effects	271
a. Average field at the coupling slot	271
b. Estimating coupling-slot power losses	272
5. Power losses in dielectric and magnetic materials for CFish problems	273
<b>G. Field-interpolation algorithm in SFO</b>	<b>274</b>
<b>H. Transit-time-factor integrals</b>	<b>274</b>
1. Variables used with whole-cavity transit-time integrals	277
2. SFDATA line for older versions of Parmila	278
<b>I. Multicell calculations in SFO</b>	<b>279</b>
1. Multicell transit-time-factor integrals	279
2. Transit-time-factor data versus $\beta$	280
a. Tablplot files of T versus $\beta$	281
b. PMI files for Parmila for each $\beta$	282
3. Stems and post couplers in a multicell tank	283
<b>J. The SFO output summary</b>	<b>284</b>
1. Particle rest mass, velocity, and kinetic energy	284
2. Accelerator figures of merit	285
3. Peak magnetic and electric fields and the Kilpatrick factor	286
4. Power and frequency-shift tables	287
<b>K. SFO error messages</b>	<b>289</b>
<b>XI. SF7: Poisson Superfish Postprocessor for Field Interpolation</b>	<b>291</b>
<b>A. Starting program SF7</b>	<b>291</b>
1. Input using the dialog window	292

2. Input using the command file	292
a. Line keyword for interpolation along a line	293
b. Arc keyword for interpolation along a circular arc	293
c. Curve keyword for interpolation along a user-supplied curve	294
d. Grid keyword for interpolation on a rectangular grid	294
e. Parmela keyword to create input for program Parmela	294
f. EGUN keyword to create input for program EGUN	295
<b>B. SF7 files and filename conventions</b>	<b>295</b>
<b>C. SF7 output text file</b>	<b>296</b>
<b>D. Creating Tablplot files of the interpolated fields</b>	<b>296</b>
1. Plotting Slater-Perturbation Frequency Shifts	297
<b>E. Power and stored energy integrals in SF7</b>	<b>298</b>
<b>F. Field-interpolation algorithm in SF7</b>	<b>299</b>
<b>G. Writing real and imaginary CFish fields</b>	<b>301</b>
<b>H. SF7 error messages</b>	<b>302</b>
<b>XII. Force: Poisson Postprocessor for Calculating Magnetic Forces</b>	<b>303</b>
<b>A. Starting program Force</b>	<b>303</b>
<b>B. Force files and filename conventions</b>	<b>304</b>
<b>C. Output from Force</b>	<b>304</b>
1. Output for Cartesian coordinates	304
2. Output for cylindrical coordinates	304
<b>D. Iron or coil region on which to calculate the force</b>	<b>305</b>
<b>E. Other considerations when using Force</b>	<b>305</b>
1. Force does not make use of symmetry planes	305
2. Meshing the problem geometry	305
3. Possible sign errors in the force components	305
<b>F. Force error messages</b>	<b>306</b>
<b>XIII. Automated Tuning Programs</b>	<b>307</b>
<b>A. The tuning programs and their cavity shapes</b>	<b>307</b>
1. DTLfish: a tuning program for drift-tube linacs	307
a. DTLfish cavity shape	307
b. DTLCells, companion program for generating each Parmila cell	308
2. CCLfish: a tuning program for coupled-cavity linacs	310
a. Shape 0, standard coupled-cavity linac cell	311
b. Optional tuning surfaces for standard coupled-cavity linac cell	311
c. Shape 1, disk-loaded waveguide cell	316
d. Shape 2, special end-wall shape	317
e. CCLCells, companion program for generating each Parmila cell	317
3. ELLfish: a tuning program for elliptical cavities	318
a. Symmetric half cavity	318
b. Full cavity with attached bore tube	320
c. ELLCAV, companion program for generating the multicell-cavity file	321

4. MDTfish: a tuning program for multiple-cell drift-tube linacs	322
a. MDTfish cavity shape	322
b. MDTCells, companion program, converts DTLfish input to MDTfish input	323
5. CDTfish: a tuning program for coupled-cavity drift-tube linacs	323
a. Coupled-cavity drift-tube linac cavity shapes	323
6. RFQfish: a tuning program for radio-frequency quadrupoles	328
a. RFQfish cavity shape	328
7. SCCfish: a tuning program for side coupling cavities	330
<b>B. Starting and stopping the tuning programs</b>	<b>330</b>
1. Using the Esc key to stop a tuning code or a Superfish run	331
<b>C. Session, problem, and run: tuning program terminology</b>	<b>331</b>
<b>D. Files used in the tuning codes</b>	<b>332</b>
1. The control file and tuned-data file	332
2. The tuning program LOG file	334
3. Automesh input file for a Superfish run	334
4. SFO file, SFO output file	334
5. SEG file, Input file for program SFO	334
<b>E. Control file keywords common to all tuning programs</b>	<b>335</b>
1. TITLE and ENDTITLE, Defining the problem description	336
2. Control-file comment-line indicators	336
3. ENDFILE, The last line in the control file	336
4. PARTICLE and REST_mass, Particle type for kinetic energy calculation	337
5. Keywords specifying the surface resistance	337
6. Filenames for each problem in the control file	339
7. Setting the target frequency and tolerance	339
8. Setting the mesh size in the problem geometry	340
a. Controlling line regions through the drift tube in DTLfish and MDTfish	340
9. Linking parameters to previously calculated values	341
10. Setting the preferred normalization method	341
11. Saving binary solution files for each completed problem	342
<b>F. Control-file keywords specific to each tuning code</b>	<b>342</b>
1. DTLfish control-file keywords	343
2. CCLfish control-file keywords	344
a. Selecting either Neumann or Dirichlet boundary conditions in CCLfish	344
3. ELLfish control-file keywords	345
4. MDTfish control-file keywords	346
a. Entering the cell data in MDTfish	347
b. Stem and post-coupler data in MDTfish	348
c. Example stem configurations	348
d. Example post-coupler configurations	350
5. CDTfish control-file keywords	350
a. Full-cavity or half-cavity problems and the number of gaps	350
b. Gap-shift parameters in the CDTfish control file	351
c. Using unequal face angles on drift tubes	353
6. RFQfish control-file keywords	354
a. Defining the RFQfish tuning parameters	354
b. Field normalization in RFQfish	356
7. SCCfish control-file keywords	356

<b>G. Drift-tube nose shape in cylindrically symmetric cavities</b>	<b>357</b>
1. CCLfish cavities with no nose	358
<b>H. Cell lengths and gap lengths in tuning codes</b>	<b>358</b>
<b>I. Using the START code to tune a cavity</b>	<b>359</b>
1. START codes for DTLfish	359
2. START codes for CCLfish	360
3. START codes for ELLfish	360
4. START codes for MDTfish	361
5. START codes for CDTfish	361
6. START codes for RFQfish	362
7. START codes for SCCfish	362
<b>J. Drift-tube stems in DTLfish, MDTfish, and CDTfish</b>	<b>363</b>
<b>K. Converting old DATA/ENDDATA sections to the new format</b>	<b>363</b>
1. Converting an old DTLfish file to the new format	364
2. Converting an old CCLfish file to the new format	364
<b>XIV. Plotting Programs Quikplot and Tablplot</b>	<b>367</b>
<b>A. Starting a plotting code</b>	<b>367</b>
1. Opening files	368
2. Editing files	368
3. Stopping the program	368
<b>B. Input data files</b>	<b>368</b>
1. Quikplot data format	368
a. Curve labels	369
b. Mathematical operations	369
2. Tablplot data format	371
a. Column titles	372
b. Axis labels	372
c. Curve labels	372
d. Option to skip lines	372
e. Mathematical operations	372
<b>C. Main display window</b>	<b>373</b>
1. Display features	376
a. Abscissa and ordinate axes	376
b. X and Y scales, zoom levels	376
c. Plot title and coordinate axes	377
d. Marker size and type	377
e. Curve labels	377
f. Line widths	378
2. Arithmetic operations in Quikplot and Tablplot	378
3. Interchanging the X and Y axes in Quikplot	379
4. Sorting and point labeling in Tablplot	379
5. Constructing a new data column in Tablplot	380
6. Selecting data to display	380
a. Locking the Y-axis scale in Tablplot	380
7. Fitted curves	381
a. Interpolating a value from the fitted curve	381

b. Plotting the residuals of the fit	381
c. Integrating the fitted curve or the data	381
<b>D. Output from the plotting codes</b>	<b>381</b>
1. Log file	382
2. Hardcopy of graphics screens	382
3. Quikplot and Tablplot preference files	383
4. Tab-delimited text files	383
5. New Quikplot and Tablplot files	384
<b>E. Sample input files</b>	<b>384</b>
1. Example data file for Quikplot	384
2. Example data file for Tablplot	385
<b>XV. Utility Programs</b>	<b>388</b>
<b>A. List35: lists the contents of the binary solution file</b>	<b>388</b>
1. LAST35, indicates the last program to update the binary solution file	390
<b>B. SFOTable: make Tablplot file from families of SFO files</b>	<b>391</b>
1. Starting program SFOTable	392
2. Files used in SFOTable	392
3. The SFOTable control file	392
a. OUTPUT file, name of the Tablplot file	393
b. Filenames for SFO files	393
c. Field normalization options in SFOTable	393
d. Including tuning-code setup parameters in the Tablplot file	394
e. EndFile, the last line in the file	395
4. SFOTable sample control file and output file	395
<b>C. SegField: make plot files of fields on boundary segments</b>	<b>398</b>
<b>D. Beta: lists particle <math>\beta</math> as a function of kinetic energy</b>	<b>400</b>
<b>E. Kilpat: calculate the Kilpatrick field for a given frequency</b>	<b>401</b>
<b>F. ConvertF: convert frequencies between different conditions</b>	<b>402</b>
<b>G. FScale: Scale dimensions in tuning-code control files</b>	<b>406</b>
<b>H. SF8: Coupling slot effects</b>	<b>407</b>
1. Starting program SF8	407
2. Files used in SF8	407
3. The SF8 control file	407
a. Cavity keywords	408
b. FREQUENCY keyword	410
4. Mathematical formulas in SF8	411
<b>I. MK_SFINI: Create or update file SF.INI.</b>	<b>414</b>
<b>XVI. RF Field Examples (Autofish, Fish, CFish)</b>	<b>415</b>
<b>A. The PillboxCavities directory</b>	<b>415</b>
1. PILL1.AF, a short pillbox cavity	416
2. MODPILL.AF, a pillbox cavity with bore tube	420
<b>B. The CFish directory</b>	<b>421</b>

a. Coaxial waveguide example	421
b. Pillbox with dielectric rod	424
c. Power losses in dielectrics	424
d. Waveguide power splitter	424
<b>C. The FrequencyScan directory</b>	<b>425</b>
a. The on-axis coupled cavity and resonance searches	426
b. Frequency scans	428
c. Plotting fields along segments	429
<b>D. The SphericalCavity directory</b>	<b>430</b>
<b>E. The RFQCavity directory</b>	<b>432</b>
a. One-eighth of an RFQ cavity	432
b. One-fourth of an RFQ cavity	435
<b>F. The QuarterWaveResonator directory</b>	<b>438</b>
<b>G. The FerriteCavity directory</b>	<b>438</b>
<b>H. The Waveguides directory</b>	<b>442</b>
1. Rectangular waveguide TE modes	443
2. Hexagonal waveguide TE modes	444
<b>XVII. Magnetostatic Examples (Poisson, Pandira)</b>	<b>447</b>
<b>A. The H-Magnet directory</b>	<b>447</b>
1. The H-shaped magnet example HTEST1	448
2. The H-shaped magnet example HTEST2.AM	453
3. Full-geometry example HFULL.AM for the H-shaped magnet	454
4. Force calculation for problem HFULL.AM	459
<b>B. The Dipoles directory</b>	<b>460</b>
<b>C. The Quadrupoles directory</b>	<b>460</b>
<b>D. The ForceTest and ForceOnWires directories</b>	<b>461</b>
1. Force between current loops	462
<b>E. The PMCylinders directory</b>	<b>464</b>
<b>F. The PMDipoles directory</b>	<b>464</b>
1. Dipole magnet made from blocks of permanent-magnet material	465
2. Permanent-magnet dipole with variable easy axis direction	468
<b>G. The PMQuads directory</b>	<b>470</b>
1. Full geometry permanent-magnet quadrupole	471
2. Permanent-magnet quadrupole with variable easy axis direction	476
3. Quarter geometry permanent-magnet quadrupole	478
<b>H. The POAsample directory</b>	<b>480</b>
<b>I. The Septum directory</b>	<b>483</b>
<b>J. The Solenoids directory</b>	<b>484</b>
<b>K. The Shielding directory</b>	<b>484</b>
<b>L. The StoredEnergy directory</b>	<b>487</b>

<b>XVIII. Electrostatic Examples (Poisson, Pandira)</b>	<b>488</b>
<b>A. The ChargeDensity directory</b>	<b>488</b>
<b>B. The CoaxCapacitor directory</b>	<b>491</b>
<b>C. The CoaxCylinder directory</b>	<b>491</b>
<b>D. The Dielectrics directory</b>	<b>491</b>
<b>E. The IonSource directory</b>	<b>492</b>
<b>F. The Plates directory</b>	<b>492</b>
<b>G. The QuadLens directory</b>	<b>492</b>
<b>H. The StoredEnergy directory</b>	<b>493</b>
<b>XIX. Tuning Program Examples</b>	<b>495</b>
<b>A. The CCL directory</b>	<b>495</b>
1. A conventional CCL cell	495
2. Special shape option for the cavity wall	498
<b>B. The CCDTL directory</b>	<b>499</b>
1. Full-cavity 1-drift-tube example	500
2. Half-cavity 2-drift-tube cavity	500
<b>C. The DTL directory</b>	<b>504</b>
1. Using different tuning surfaces	505
2. Computing the fields for a specific design without tuning	506
<b>D. The EllipticalCavity directory</b>	<b>510</b>
1. Symmetric half cell	512
2. Full cell at the end of a multicell cavity	514
3. ELLCAV, generation of the multicell cavity	516
4. SegField, displaying fields along the cell boundary	516
<b>E. The MulticellDTL directory</b>	<b>517</b>
<b>F. The RFQ directory</b>	<b>519</b>
1. Several tuning options for RFQ cavities	519
2. LANSCE RFQ design examples	525
<b>G. The SideCouplingCell directory</b>	<b>527</b>
<b>XX. Theory of Electrostatics and Magnetostatics</b>	<b>531</b>
<b>A. Maxwell's equations</b>	<b>531</b>
<b>B. Isotropic magnetostatics in Cartesian coordinates</b>	<b>532</b>
<b>C. Isotropic electrostatics in Cartesian coordinates</b>	<b>534</b>
<b>D. Isotropic magnetostatics in cylindrical coordinates</b>	<b>536</b>
<b>E. Isotropic electrostatics in cylindrical coordinates</b>	<b>537</b>
<b>F. Anisotropic magnetostatics in Cartesian coordinates</b>	<b>539</b>

1. Easy axis in a fixed direction	540
2. Easy axis on an off-center circle	543
<b>G. Anisotropic electrostatics in Cartesian coordinates</b>	<b>545</b>
<b>H. Anisotropic magnetostatics in cylindrical coordinates</b>	<b>547</b>
<b>I. Anisotropic electrostatics in cylindrical coordinates</b>	<b>548</b>
<b>XXI. Properties of Static Magnetic and Electric Fields</b>	<b>549</b>
<b>A. Energy stored in the field</b>	<b>549</b>
<b>B. Fields and their derivatives</b>	<b>553</b>
<b>C. Forces and torques</b>	<b>565</b>
<b>XXII. Boundary Conditions and Symmetries</b>	<b>573</b>
<b>A. Boundary conditions</b>	<b>573</b>
1. Magnetic field near Dirichlet boundary	575
2. Electric field near Dirichlet boundary	575
3. Magnetic field near Neumann boundary	575
4. Electric field near Neumann boundary	576
<b>B. Symmetry considerations</b>	<b>576</b>
1. Reflection symmetry	576
2. Rotational symmetry	577
<b>XXIII. Numerical Methods in Poisson and Pandira</b>	<b>579</b>
<b>A. Mesh formulation</b>	<b>579</b>
<b>B. Calculation of the vector potential at a mesh point</b>	<b>580</b>
<b>C. Application of boundary conditions</b>	<b>594</b>
<b>D. Calculation of fields</b>	<b>596</b>
<b>E. Computer algorithm using the SOR method</b>	<b>597</b>
<b>F. Computer algorithm using the direct method</b>	<b>598</b>
<b>XXIV. RF Cavity Theory</b>	<b>599</b>
<b>A. Introduction to rf cavity theory for Superfish</b>	<b>599</b>
1. TM and TE modes in cylindrical coordinates	600
2. TE modes in Cartesian coordinates	602
3. Formulas for auxiliary quantities in cylindrical coordinates	603
a. Energy per unit volume	603
b. Power losses on walls	603
c. Power losses on stems	604
d. Average accelerating field	604
e. Shunt impedance	604
f. Quality factor	604
g. Maximum electric field	605
h. Frequency perturbations	605
4. Units	605



5. Method of solution using a drive point _____	605
<b>B. Detailed development of the RF cavity theory _____</b>	<b>607</b>
1. Maxwell's equations in cylindrical coordinates _____	608
2. Application of Poynting's theorem _____	611
3. The $D(k^2)$ function _____	611
4. Solving problems in Cartesian coordinates _____	614

## List of Tables

Table II-1. Disk directories. _____	10
Table II-2. Subdirectories directly under LANL\Examples. _____	10
Table II-3. Miscellaneous files in the LANL directory. _____	11
Table II-4. Files listing code changes. _____	14
Table II-5. Contents of DeveloperFiles\PoissonSuperfish subdirectories _____	15
Table II-6. Function INTERP return values. _____	17
Table II-7. Files for use with LF95 main programs. _____	20
Table II-8. Fortran modules. _____	22
Table II-9. Variables module SF_CTRL. _____	23
Table II-10. Arrays in ComplexTape35Arrays and RealTape35Arrays. _____	25
Table II-11. Variables in ComplexTape35Arrays and RealTape35Arrays. _____	26
Table II-12. Variables in module PoissonSuperfishData. _____	26
Table II-13. Variables in module InterpolatedFields. _____	27
Table II-14. Material arrays indexed by material ID number. _____	29
Table II-15. Shape of arrays in Table II-14. _____	29
Table II-16. Meaning of the line-parser calling parameters. _____	31
Table II-17. Line-parser variables available to the calling program. _____	32
Table II-18. Meaning negative values of NCHR. _____	32
Table II-19. Settings for array verification. _____	33
Table III-1. Topics from the 1987 Reference Manual _____	44
Table III-2. The tuning programs. _____	55
Table III-3. Superfish variables. _____	76
Table III-4. Poisson variables. _____	80
Table III-5. Alphabetical list of SF.INI settings. _____	83
Table III-6. Poisson Superfish warning messages. _____	90
Table III-7. Filename extensions for hardcopy graphics types. _____	92
Table III-8. WSFplot display parameters in SF.INI. _____	93
Table III-9. Power-law settings for WSFplot contour lines. _____	94
Table III-10. Quikplot and Tablplot parameters in SF.INI. _____	96
Table III-11. SF7 expanded data-table columns. _____	97
Table III-12. SF7 parameters in SF.INI. _____	98
Table III-13. Beta display parameters in SF.INI. _____	100
Table III-14. SF.INI variable SlaterTerm for WSFplot and SF7. _____	107
Table III-15. Electromagnetic theory sections. _____	110
Table III-16. Memory requirements of the codes. _____	117
Table III-17. Lengths of some allocated arrays. _____	118
Table I-1. Files used in Poisson Superfish. _____	122
Table I-2. Registered file types. _____	124
Table I-3. Right mouse button menu for T35 files. _____	124
Table I-4. Frequency scan data written by Fish. _____	136
Table I-5. Frequency scan data written by CFish. _____	136
Table I-6. Transit-time data in file Transit.TBL. _____	137
Table I-7. Transit-time data in file TBeta.TBL. _____	138
Table I-8. Automesh namelist parameters that indicate the cavity type. _____	144
Table VI-1. REG namelist variables. _____	149
Table VI-2. REG variables that affect the default value of DY. _____	155
Table VI-3. Material numbers. _____	156

Table VI-4. PO namelist variables. _____	156
Table VI-5. MT namelist variables. _____	159
Table VI-6. REG namelist material arrays in the binary solution file. _____	160
Table VI-7. The three possible values for MODE. _____	163
Table VI-8. Values of MSHAPE when MODE = 0. _____	164
Table VI-9. MT namelist variables for anisotropic materials. _____	166
Table VI-10. The meaning of IPERM. _____	168
Table VI-11. POA namelist variables. _____	168
Table VI-12. Variables affected by the choice for CONV. _____	173
Table VI-13. Length units. _____	173
Table VI-14. Default boundary conditions at the edges of the geometry. _____	174
Table VI-15. Default boundary conditions for region boundaries. _____	174
Table VI-16. REG namelist variables for the first 8 line regions. _____	180
Table VI-17. Formats for displaced nodes. _____	183
Table VI-18. The three possible values for triangle type ITRI. _____	185
Table VI-19. REG namelist variables that specify a cavity type. _____	187
Table VI-20. The C-array parameters that determine the initial potential. _____	189
Table VI-21. Automesh error messages. _____	195
Table VII-1. Variables used by Fish and CFish. _____	201
Table VII-2. Frequency-scan variables. _____	202
Table VII-3. Methods for estimating the frequency at the next iteration. _____	204
Table VII-4. Relaxed convergence parameters used by the tuning programs. _____	205
Table VII-5. Parameters that affect convergence in Superfish. _____	208
Table VII-6. Fish and CFish error messages. _____	210
Table VIII-1. Variables used by Poisson and Pandira. _____	212
Table VIII-2. Variables related to permeability in Poisson and Pandira. _____	214
Table VIII-3. Variables for scaling the Poisson fields. _____	219
Table VIII-4. Variables defining the field-interpolation region. _____	225
Table VIII-5. Variables that control the harmonic analysis. _____	230
Table VIII-6. Symmetry options for the harmonic analysis. _____	231
Table VIII-7. Meaning of median-plane symmetry in Table VIII-6. _____	231
Table VIII-8. Variables that control conformal mapping. _____	232
Table VIII-9. Variables related to Poisson and Pandira convergence tests. _____	233
Table VIII-10. Parameters that affect convergence in Poisson or Pandira. _____	236
Table VIII-11. Number of cycles to converge versus RHOAIR. _____	237
Table VIII-12. Error messages for Poisson and Pandira. _____	240
Table IX-1. WSFplot menu items. _____	242
Table IX-2. Contour settings in SF.INI _____	244
Table IX-3. Power-law settings for WSFplot contour lines. _____	245
Table IX-4. Plot orientation menu items. _____	247
Table IX-5. The WSFplot color parameters in SF.INI. _____	247
Table IX-6. The WSFplot line-width parameters in SF.INI. _____	248
Table IX-7. Options for calculating material power losses. _____	250
Table IX-8. HP-GL Color Translation. _____	253
Table IX-9. WSFplot error messages. _____	255
Table X-1. Problem variables used by SFO. _____	257
Table X-2. Table headings in the SFO input file. _____	259
Table X-3. Variables that affect the Superfish field normalization. _____	260
Table X-4. The field normalization methods. _____	260
Table X-5. Methods for computing surface resistance. _____	264

Table X-6. Variables that affect the surface resistance.	264
Table X-7. Variables for each method of computing surface resistance.	266
Table X-8. Properties of common metals.	267
Table X-9. Brazing alloy resistivities.	267
Table X-10. Field enhancement factor $\lambda$ versus $c/b$ .	270
Table X-11. Variables for the average field near the coupling slot.	272
Table X-12. Variables affecting coupling slot power estimates.	273
Table X-13. Variables used with whole-cavity transit-time integrals.	278
Table X-14. SFDATA parameters for old versions of Parmila.	278
Table X-15. Variables used with multiple-cell transit-time integrals.	279
Table X-16. CellData columns for multicell transit-time integrals.	279
Table X-17. Variables for plotting transit-time data versus $\beta$ .	281
Table X-18. IBETA settings for SFO.	281
Table X-19. Stem and post-coupler parameters.	284
Table X-20. Code numbers and rest masses for some charged particles.	285
Table X-21. Data columns in the table of wall segments.	288
Table X-22. Data columns for multicell stems and post couplers	288
Table X-23. SFO error messages.	289
Table XI-1. SF7 command keywords and data entry lines.	293
Table XI-2. SF7 optional keywords.	293
Table XI-3. Shape factors for settings of variable SlaterTerm.	298
Table XI-4. SF7 expanded data-table columns.	300
Table XI-5. SF7 error messages.	302
Table XII-1. Force error messages.	306
Table XIII-1. Column headings in drift-tube geometry table.	310
Table XIII-2. Cavity types in CCLfish.	311
Table XIII-3. Tuning ring options in CCLfish.	312
Table XIII-4. Equator tuning ring effects in three cavities.	316
Table XIII-5. Tuning ring options in CDTfish.	327
Table XIII-6. Tuning program terminology.	331
Table XIII-7. Tuning program files.	332
Table XIII-8. Control file keywords common to all the tuning programs.	336
Table XIII-9. Symbols for some common ions.	337
Table XIII-10. Control file keywords for specifying the surface resistance.	338
Table XIII-11. Normal-conductor parameters used with the TEMPerature keyword.	338
Table XIII-12. Parameters used with the SUPERConductor keyword.	338
Table XIII-13. Files created by the tuning program.	339
Table XIII-14. DTLfish control-file keywords	343
Table XIII-15. CCLfish control-file keywords.	344
Table XIII-16. ELLfish control-file keywords.	346
Table XIII-17. MDTfish control-file keywords.	347
Table XIII-18. Data columns after the CELL_data keyword.	347
Table XIII-19. CDTfish control-file keywords.	352
Table XIII-20. RFQfish control-file keywords.	354
Table XIII-21. Data columns after the DATA keyword in the RFQfish control file.	355
Table XIII-22. SCCfish control-file keywords.	357
Table XIII-23. START codes for DTLfish.	360
Table XIII-24. START codes for CCLfish.	360
Table XIII-25. START codes for ELLfish	361

Table XIII-26. START codes for MDTfish.	361
Table XIII-27. START codes for CDTfish.	362
Table XIII-28. START codes for RFQfish.	362
Table XIII-29. START codes for SCCfish.	363
Table XIV-1. Quikplot input-file keywords.	370
Table XIV-2. Tablplot input-file keywords.	371
Table XIV-3. Mathematical operations upon starting Tablplot.	373
Table XIV-4. Quikplot menu items.	374
Table XIV-5. Tablplot menu items.	375
Table XIV-6. Arithmetic operations.	379
Table XIV-7. Tablplot algebraic operations.	380
Table XIV-8. Fit menu items for selecting a fitted curve.	381
Table XV-1. Column headings for the region material table.	389
Table XV-2. Column headings for the mesh-point data table.	389
Table XV-3. LAST35 code numbers.	390
Table XV-4. SFOTable control-file keywords.	393
Table XV-5. SegField control-file keywords.	398
Table XV-6. Columns in the SegField output file.	399
Table XV-7. Thermal expansion data.	403
Table XV-8. Dielectric constants of gases.	404
Table XV-9. SF8 control-file keywords.	408
Table XVI-1. Files in directory Examples\RadioFrequency.	415
Table XVI-2. Files in directory RadioFrequency\PillboxCavities.	416
Table XVI-3. Files in directory RadioFrequency\CFish.	422
Table XVI-4. Files in directory RadioFrequency\FrequencyScan.	426
Table XVI-5. Files in directory RadioFrequency\SphericalCavity.	430
Table XVI-6. Files in directory RadioFrequency\RFQCavity.	432
Table XVI-7. Files in directory RadioFrequency\QuarterWaveResonator.	438
Table XVI-8. Files in directory RadioFrequency\FerriteCavity.	438
Table XVI-9. Files in directory RadioFrequency\Waveguides.	442
Table XVII-1. Files in directory Examples\Magnetostatic.	447
Table XVII-1. Files in directory Magnetostatic\H-Magnet.	448
Table XVII-2. Files in directory Magnetostatic\Dipoles.	460
Table XVII-3. Files in directory Magnetostatic\Quadrupoles.	460
Table XVII-4. Files in directory Magnetostatic\ForceTest.	461
Table XVII-5. Files in directory Magnetostatic\ForceOnWires.	462
Table XVII-6. Files in directory Magnetostatic\PMcylinders.	464
Table XVII-7. Files in directory Magnetostatic\PMdipoles.	465
Table XVII-8. Files in directory Magnetostatic\PMquads.	471
Table XVII-9. Files in directory Magnetostatic\POAsample.	481
Table XVII-10. Files in directory Magnetostatic\Septum.	483
Table XVII-11. Files in directory Magnetostatic\Solenoids.	484
Table XVII-12. Files in directory Magnetostatic\Shielding.	484
Table XVII-13. Files in directory Magnetostatic\StoredEnergy.	487
Table XVIII-1. Files in directory Examples\Electrostatic.	488
Table XVIII-2. Files in directory Electrostatic\ChargeDensity.	489
Table XVIII-3. Files in directory Electrostatic\CoaxCapacitor.	491
Table XVIII-4. Files in directory Electrostatic\CoaxCylinder.	491
Table XVIII-5. Files in directory Electrostatic\Dielectrics.	491
Table XVIII-6. Files in directory Electrostatic\IonSource.	492

Table XVIII-7. Files in directory Electrostatic\Plates.	492
Table XVIII-8. Files in directory Electrostatic\QuadLens.	493
Table XVIII-9. Files in directory Electrostatic\StoredEnergy.	493
Table XIX-1. Files in directory CavityTuning\CCL.	495
Table XIX-2. Files in directory CavityTuning\CCDTL.	500
Table XIX-3. Files in directory CavityTuning\DTL.	504
Table XIX-4. Files in directory CavityTuning\EllipticalCavity.	511
Table XIX-5. Files in directory CavityTuning\MulticellDTL.	517
Table XIX-6. Files in directory CavityTuning\RFQ.	519
Table XIX-7. RFQ vane parameters for three problems.	520
Table XIX-8. Files in directory CavityTuning\SideCouplingCell.	528
Table XXI-1. The first 10 harmonic polynomials.	556
Table XXI-2. Harmonic polynomials for cylindrical coordinates.	564
Table XXII-1. Boundary condition terminology.	574
Table XXII-2. Field directions near Dirichlet and Neumann boundaries.	575

## List of Figures

Figure II-1. Fortran 90 declarations for DLL functions. _____	16
Figure II-2. Example LF95.Fig file. _____	21
Figure II-3. The six triangles surrounding a mesh point. _____	34
Figure III-1. Square-wave electric field distribution. _____	68
Figure III-2. Triangular mesh showing reference point and neighboring points. _____	109
Figure I-1. SFO input file written by DTLfish. _____	130
Figure I-1. A sample PMI file for a single-gap problem. _____	144
Figure I-2. A sample PMI file for a multicell problem. _____	145
Figure VI-1. Sample input file illustrating the use of MAT. _____	161
Figure VI-1. A sample MT namelist with a (B, $\gamma$ ) material table. _____	165
Figure VI-2. B-H relationships for an anisotropic permanent-magnet material. _____	166
Figure VI-3. Sample input file defining permanent magnet materials _____	166
Figure VI-4. Automesh input file for a pillbox cavity. _____	170
Figure VI-5 Automesh input file for a cavity with an elliptical segment. _____	170
Figure VI-6. Automesh input file for an H-shaped magnet. _____	171
Figure VIII-1 B-H curves (linear scale) for the internal permeability tables. _____	215
Figure VIII-2. B-H curves (log scale) from Figure VIII-1. _____	215
Figure VIII-3. Flux density B versus field strength H. _____	220
Figure VIII-4. One quarter of a symmetric H-shaped magnet. _____	227
Figure X-1. SFO input file for first code run. _____	259
Figure X-2. SFO input file for second code run. _____	260
Figure X-3. SFO input file containing surface resistance data. _____	265
Figure X-4. Coupling slots in a CCDTL. _____	272
Figure X-5. Coupling-slot data in the SFO output file. _____	273
Figure X-6. Half of a six-cell cavity. _____	282
Figure X-7. SFO input file created by ELLCAV _____	283
Figure XI-1. Sample SF7 input for interpolation along a line. _____	293
Figure XI-2. Sample SF7 input for interpolation along an arc. _____	294
Figure XI-3. Sample SF7 input for interpolation along a user-supplied curve. _____	294
Figure XI-4. Sample SF7 input for interpolation on a rectangular grid. _____	294
Figure XI-5. Sample SF7 input containing several commands. _____	297
Figure XI-6. Interpolation path between mesh rows. _____	300
Figure XIII-1. The DTL half cell set up by the code DTLfish. _____	308
Figure XIII-2. Detail near the drift-tube nose. _____	309
Figure XIII-3. The CCL half cell set up by the code CCLfish. _____	312
Figure XIII-4. Detail near the nose in a CCL cell. _____	313
Figure XIII-5. Optional equator tuning ring in CCL cavities. _____	313
Figure XIII-6. Optional wall tuning rings in CCL and CCDTL cavities. _____	314
Figure XIII-7. A section of a disk-loaded waveguide. _____	316
Figure XIII-8. A CCLfish cavity with special shape parameters. _____	317
Figure XIII-9. The right half of an elliptical cavity. _____	319
Figure XIII-10. Full-cell elliptic cavity. _____	320
Figure XIII-11. Right half of an 8-cell cavity. _____	322
Figure XIII-12. Three full cells of a drift-tube linac setup by MDTfish. _____	323
Figure XIII-13. Full cavity of a one-drift-tube, 2-gap CCDTL. _____	324
Figure XIII-14. Half of a two-drift-tube, 3-gap CCDTL cavity. _____	325
Figure XIII-15. Details near the drift tube in a CCDTL cavity. _____	326

Figure XIII-16. Optional equator tuning ring in a CCDTL cavity. _____	327
Figure XIII-17. Cross section of one quadrant of an RFQ cavity. _____	329
Figure XIII-18. Details near the vane tips for the RFQ quadrant. _____	329
Figure XIII-19. Side coupling cavities. _____	330
Figure XIII-20. Typical input file for program Automesh. _____	333
Figure XIII-21. Typical SEG file for program SFO. _____	334
Figure XV-1. Sample XFREQ.TXT output from ConvertF. _____	405
Figure XV-2. Coupling slot location in a CCL cavity. _____	409
Figure XV-3. Sample SF8 control file. _____	411
Figure XVI-1. The batch file RUNPILL.BAT. _____	417
Figure XVI-2. The PILL1.AF input file for Autofish. _____	417
Figure XVI-3. Triangular mesh and field contours for the PILL1.AF example. _____	418
Figure XVI-4. Input file PILL1.SEG for SFO. _____	418
Figure XVI-5. Input file PILL1B.SEG for SFO. _____	418
Figure XVI-6. Input file PILL1C.SEG for SFO. _____	419
Figure XVI-7. Input file PILL1D.SEG for SFO. _____	419
Figure XVI-8. Input file PILL1E.SEG for SFO. _____	420
Figure XVI-9. Field distribution for the modified pillbox cavity. _____	420
Figure XVI-10. The MODPILL.AF input file for Autofish. _____	421
Figure XVI-11. The COAXWG.AM input file for Automesh. _____	422
Figure XVI-12. Field contours for the coaxial line problem. _____	423
Figure XVI-13. SFO input file COAXWG.SEG. _____	423
Figure XVI-14. Tablplot display of fields. _____	423
Figure XVI-15. Field contours for the waveguide power splitter. _____	425
Figure XVI-16. The batch file RUNSCAN.BAT _____	426
Figure XVI-17. The input file MODE763.AF. _____	427
Figure XVI-18. The first few lines of input file SCAN.AM. _____	427
Figure XVI-19. Modes in the on-axis coupled cavity. _____	428
Figure XVI-20. Tablplot screen showing data in FishScan.TBL. _____	429
Figure XVI-21. Input file MODE763.SGF for program SegField. _____	429
Figure XVI-22. Tablplot screen showing data in SEGS.TBL. _____	430
Figure XVI-23. The two-line batch file RUNSPHER.BAT. _____	430
Figure XVI-24. The Automesh input file SPHERE.AF. _____	431
Figure XVI-25. Field contours for the spherical cavity mode at 130 MHz. _____	431
Figure XVI-26. The batch file RUNRFQ.BAT. _____	432
Figure XVI-27. The input file 8THRFQ.AF. _____	433
Figure XVI-28. Triangular mesh for file 8THRFQ.AF. _____	434
Figure XVI-29. Field contours for the half-quadrant RFQ. _____	434
Figure XVI-30. Mesh and field contours near an RFQ vane tip. _____	435
Figure XVI-31. Title and REG namelist in Autofish input file 4THRFQ.AF. _____	436
Figure XVI-32. PO NAMLIST entries in Autofish input file 4THRFQ.AF. _____	437
Figure XVI-33. Field contours for a dipole mode in an RFQ quadrant. _____	437
Figure XVI-34. Outline of regions in the ferrite-tuned cavity. _____	439
Figure XVI-35. The batch file RUNFTEST.BAT _____	439
Figure XVI-36. Contours of $rH_\phi$ in the ferrite cavity. _____	439
Figure XVI-37. Equally spaced field contours in the ferrite-tuned cavity. _____	439
Figure XVI-38. First part of Automesh input file FTEST.AM. _____	440
Figure XVI-39. Second part of Automesh input file FTEST.AM. _____	441
Figure XVI-40. Last part of Automesh input file FTEST.AM. _____	442



Figure XVI-41. The batch file RUNWG.BAT.	442
Figure XVI-42. Automesh input file WR2300.AM.	443
Figure XVI-43. Several waveguide TE modes.	444
Figure XVI-44. Automesh input file WR2300.AM.	445
Figure XVI-45. Waveguide modes in the hexagonal guide.	446
Figure XVII-1. The batch file RUNHTEST.BAT.	448
Figure XVII-2. Title and REG namelist from input file HTEST1.AM.	449
Figure XVII-3. Air points and iron and coil regions HTEST1.AM and HTEST2.AM.	450
Figure XVII-4. One quadrant of the H magnet geometry.	451
Figure XVII-5. Triangular mesh for the HTEST1 and HTEST2 examples.	451
Figure XVII-6. Field contours for the HTEST1.AM and HTEST2.AM examples.	452
Figure XVII-7. List of points used for HTEST1.AM harmonic analysis.	452
Figure XVII-8. Coefficients computed by the harmonic analysis for HTEST1.	453
Figure XVII-9. Title and REG namelist from input file HTEST2.AM.	454
Figure XVII-10. Automesh input file HFULL.AM.	455
Figure XVII-11. Last region in Automesh input file HFULL.AM.	456
Figure XVII-12. Triangular mesh for the HFULL.AM example.	457
Figure XVII-13 Field contours for the HFULL.AM example.	457
Figure XVII-14 List of points used for the HFULL.AM harmonic analysis.	458
Figure XVII-15 Coefficients computed by the harmonic analysis for HTEST1.AM.	459
Figure XVII-16. Force input file HFULL.FCE.	459
Figure XVII-17. The batch file RUNPMDIP.BAT.	465
Figure XVII-18. Geometry of the permanent magnet dipole.	466
Figure XVII-19. The Automesh input file PMDIPOLE.AM.	467
Figure XVII-20. Field contours for problem PMDIPOLE.AM.	468
Figure XVII-21 The Automesh input file PMDVAR.AM.	469
Figure XVII-22. Field contours for the PMDVAR.AM example.	470
Figure XVII-23. The batch file RUNPMQ.BAT.	471
Figure XVII-24a. Start of Automesh input file PMQUAD1.AM.	472
Figure XVII-25. Field contours for problem PMQUAD1.AM.	475
Figure XVII-26. The Automesh input file PMQUAD2.AM.	477
Figure XVII-27 Field contours for the PMQUAD2.AM example.	478
Figure XVII-28a. Start of Automesh input file PMQUAD1.AM.	479
Figure XVII-29. Field contours for the PMQUAD3.AM example.	479
Figure XVII-30. Solution of dipole problem from file POA2.AM.	481
Figure XVII-31. Region 1 mesh-point list from file OUTAUT.TXT.	482
Figure XVII-32. POA namelist sections in file POA2.AM.	483
Figure XVII-33. The batch file RUNVECP.BAT	484
Figure XVII-34. Lines of constant $A_z$ for the VECP.AM problem.	485
Figure XVII-35. Automesh input file VECP.AM.	486
Figure XVII-36. Two expanded displays of the VECP mesh.	487
Figure XVIII-1. WSFplot display for problem C1Q.AM.	490
Figure XVIII-2. Interpolated fields for problem C1Q.AM.	490
Figure XIX-1. CCLfish control file 805CCL.CCL.	496
Figure XIX-2. Mesh and field contours for input file 805CCL2.AM.	497
Figure XIX-3. CCLfish control file 425 EW.CCL.	498
Figure XIX-4 Mesh and field contours for input file 425EW1.AM.	499
Figure XIX-5. CDTfish control file 1DTFC.CDT.	501
Figure XIX-6. Mesh and field contours for a 1-drift-tube CCDTL cavity.	502
Figure XIX-7. CDTfish control file 2DTHC.CDT.	503

Figure XIX-8. Mesh and field contours for a 2-drift-tube CCDTL cavity. _____	504
Figure XIX-9a. First part of DTLfish control file DTLTEST.DTL. _____	505
Figure XIX-10a. First part of DTLfish control file RGFISH.DTL. _____	507
Figure XIX-11. Mesh and field contours for two RGFISH.DTL examples. _____	509
Figure XIX-12. Tablplot display of cavity parameters in file RGDTL.TBL. _____	510
Figure XIX-13. The file Run_ELL.BAT. _____	511
Figure XIX-14. ELLfish control file 82B.ELL. _____	512
Figure XIX-15. Mesh and field contours for input file 82B1.AM. _____	513
Figure XIX-16. Field contours for input file 82BE1.AM. _____	514
Figure XIX-17. ELLfish control file 82BE.ELL. _____	515
Figure XIX-18. Half of the full 8-cell cavity. _____	516
Figure XIX-19. Tablplot screen showing the fields and radiation pressure. _____	517
Figure XIX-20. Control file MDTTEST.MDT for program MDTfish. _____	518
Figure XIX-21. Mesh and field contours for the 3-cell DTL problem. _____	519
Figure XIX-22a. First part of file RFQTEST.RFQ for program RFQfish. _____	521
Figure XIX-23. Mesh generated for input file RFQ_A1.AM. _____	523
Figure XIX-24. Field contours for file RFQ_A1. _____	524
Figure XIX-25. Cavity shapes for the eight RFQTEST.RFQ problems. _____	524
Figure XIX-26. RFQfish control file LANSCE.RFQ. _____	526
Figure XIX-27. Cavity shapes for the four LANSCE.RFQ problems. _____	527
Figure XIX-28 SCCfish control file 805CC.SCC. _____	528
Figure XIX-29. Mesh for problems 805CC1.AM and 805CC2.AM. _____	529
Figure XIX-30. WSFplot field contours for problems 805CC1.AM and 805CC2.AM. _____	530
Figure XX-1. The geometry of the line and area integrals. _____	533
Figure XX-2. Cylindrical volume in Cartesian coordinates. _____	535
Figure XX-3. Area and contour path in cylindrical coordinates. _____	537
Figure XX-4. Volume in cylindrical coordinates. _____	538
Figure XX-5. B-H relationships for an anisotropic material. _____	540
Figure XX-6. Unit vectors for anisotropic materials. _____	540
Figure XX-7. Permanent-magnet quadrupole. _____	542
Figure XX-8. Definitions of parameters in off-center anisotropic materials. _____	542
Figure XXI-1. An arbitrary volume with 2-D Cartesian symmetry. _____	550
Figure XXI-2. Contour C for an H-shaped magnet. _____	552
Figure XXI-3. A general volume in cylindrical symmetry. _____	552
Figure XXI-4. First, second, and third neighbors of point 1. _____	557
Figure XXI-5. Four types of magnet symmetry. _____	559
Figure XXI-6. Conductor of constant cross section. _____	566
Figure XXI-7. Cylindrically symmetric conductor. _____	568
Figure XXII-1. Magnetic field lines for two type of reflection symmetry. _____	576
Figure XXII-2. Rotational symmetry. _____	577
Figure XXII-3. Using a separatrix to choose an approximate boundary condition. _____	578
Figure XXIII-1. Surface and contour elements in Equation XXIII-1. _____	580
Figure XXIII-2. Physical parameters in the mesh geometry. _____	585
Figure XXIII-3. Path of contour integration for Ampere's Law. _____	585
Figure XXIII-4. Contour integration details. _____	587
Figure XXIII-5. The vector potential is a linear function over a triangle. _____	588
Figure XXIII-6. Integration paths in adjacent triangles. _____	590
Figure XXIII-7. Cancellation of interior contours. _____	590
Figure XXIII-8. Path of contour integration on a Neumann boundary. _____	595
Figure XXIV-1 Field lines for the TM mode in a cylindrically symmetric rf cavity. _____	601

Figure XXIV-2. Waveguide geometry. _____	602
Figure XXIV-3 Six nearest neighbors of point 0 in a triangular mesh. _____	607
Figure XXIV-4 Demonstration that $D(k^2)$ has a “false” zero. _____	614



## I. How To Use This Document

This section provides some tips on navigating this documentation when viewing it on-line and on printing either the entire document or sections of it.

This document was produced using Microsoft Word, Version 7.0 (Word 95) and the Internet Assistant for Microsoft Word. You can read and print it with Word 6, Word 7, Word 97, Word 2000, and Microsoft Word Viewer. There are several ways to move from place to place without scrolling through entire files. Some navigation features will be unavailable unless you use Microsoft Word. This chapter contains some recommended settings and procedures.

We have attempted at times to convert the documentation to more recent versions of Microsoft Word (Word 97, Word 2000). These attempts have been unsuccessful, so the DOC files remain in the older format. Users of Word 97 or Word 2000 may experience problems with pictures and equations in the document. If this is a problem, try using Word Viewer. We have also attempted to create Adobe PDF files, but have found that some fonts used in equations do not translate properly to PDF files.

### A. Getting started

We realize that reading through several hundred pages of documentation can be a formidable task. We hope to make this document as comprehensive a reference as possible, but this in turn leads to a rather long work.

A good way to learn about the Poisson Superfish codes is to read the brief summary of the codes in section II.G. (in file SFINTRO.DOC) and then run the sample problems described near the end of this documentation in the file SFEXMPL1.DOC.

If you are switching from the UNIX (or VAX) version of Poisson Superfish, the Automesh program should read your input files with little or no modification. A few variables from the UNIX version are no longer used in this version of the codes. Automesh will give you warning or error messages as appropriate with suggestions on how to modify your input file. Automesh recognizes either the ampersand (&) or the dollar sign (\$) as the namelist delimiter. The first REG namelist contains all problems variables for the rf and static field solvers.

It is helpful to have a list of the problem variables handy in printed form. For quick reference, print the [Poisson variables](#) table and the [Superfish variables](#) tables found in file SFINTRO.DOC.

### B. List of the documentation files

Different parts of the Poisson Superfish documentation can be found in the following Microsoft Word files in the [LANL/Docs](#) directory.

<a href="#">SFTOC.DOC</a>	This file, containing the table of contents and suggestions for viewing and printing.
---------------------------	---

## Suggestions for viewing the documentation

<a href="#"><u>SFINTRO.DOC</u></a>	General information about the software installation, features in the codes, references, history, SF.INI configuration, and technical support.
<a href="#"><u>SFFILES.DOC</u></a>	Brief descriptions of all the input and output files used in the Poisson Superfish codes.
<a href="#"><u>SFCODES.DOC</u></a>	Information about the main programs Autofish, Automesh, Fish, CFish, Poisson, and Pandira.
<a href="#"><u>SFPOSTP.DOC</u></a>	Information about the postprocessor programs WSFplot, SFO, SF7, and Force.
<a href="#"><u>SFCODES2.DOC</u></a>	The automated tuning programs CCLfish, CDTfish, DTLfish, MDTfish, ELLfish, and RFQfish.
<a href="#"><u>SFCODES3.DOC</u></a>	General purpose plotting programs Quikplot and Tablplot, and utility programs Beta, Kilpat, List35, ConvertF, SF8, FScale, SegField, and SFOtable.
<a href="#"><u>SFEXMPL1.DOC</u></a>	Discussion of rf-field example files for Fish, CFish, and Autofish contained in the Examples\RadioFrequency subdirectories.
<a href="#"><u>SFEXMPL2.DOC</u></a>	Discussion of the static-field example files for Poisson and Pandira contained in the Examples\Magnetostatic and Examples\Electrostatic subdirectories.
<a href="#"><u>SFEXMPL3.DOC</u></a>	Discussion of the tuning-program example files contained in the Examples\CavityTuning subdirectories.
<a href="#"><u>SFPHYS1.DOC</u></a>	Theory of electrostatics and magnetostatics from John Warren's treatment in the 1987 Reference Manual
<a href="#"><u>SFPHYS2.DOC</u></a>	Properties of static magnetic and electric fields from John Warren's treatment in the 1987 Reference Manual
<a href="#"><u>SFPHYS3.DOC</u></a>	Boundary conditions and symmetries from John Warren's treatment in the 1987 Reference Manual
<a href="#"><u>SFPHYS4.DOC</u></a>	Numerical methods in Poisson and Pandira from John Warren's treatment in the 1987 Reference Manual
<a href="#"><u>SFPHYS5.DOC</u></a>	RF cavity theory from John Warren's treatment in the 1987 Reference Manual

## C. Suggestions for viewing the documentation

For viewing on your computer screen, we recommend using Normal view with the window maximized to fill the screen. Using Normal view (rather than Page Layout view) speeds up most operations in a large document. This is not a recommendation to use the Full Screen setting in the View menu since you will most likely want the use of the scroll bars. To switch to Normal View, check Normal in the View menu or click the leftmost button next to the bottom scroll bar.

## **Suggestions for viewing the documentation**

Use the Zoom command in the View menu to make the text comfortable to read on your monitor. In Word, you also can use the Percent box on the Standard toolbar. Type a number between 10 and 200 in the Percent box to choose a size other than the standard selections. Using the Wrap to Window setting described below in combination with a size a little larger than 100% makes fairly readable text.

### **1. Microsoft Word template and dictionary files**

When displaying Poisson Superfish documentation and other Los Alamos software documentation, Microsoft Word uses two files in the LANL directory. The file LANLHELP.DOT is a Word template file containing styles, macros, and other settings. We use macros in LANLHELP.DOT when editing the documentation, but users reading the documentation do not need them.

The file LANLHELP.DIC is a custom dictionary file containing a list of terms that Word would ordinarily flag as misspelled words. This file contains proper names, accelerator jargon, program keywords, SF.INI settings, and mathematical variable names used in the Los Alamos documentation. If in Word 7 you see a large number of words underlined in red, then Word is probably not using the custom dictionary LANLHELP.DIC. You can add this file to the list of custom dictionary files in the Tools, Options, Spelling tab. We also recommend checking the boxes to ignore words in upper case and words with numbers.

### **2. Settings in Microsoft Word**

You need only the Standard toolbar when viewing this document. To remove the other toolbars, leaving more room for text, click View, Toolbars... and remove the check marks on all but Standard, then click OK.

Click Tools, Options... and check the following settings. There are several items to inspect on the View tab. Under Nonprinting Characters, deselect all of the options (that is, remove the check marks). Under Show, select Wrap to Window, but deselect Draft Font, Picture Placeholders, Field Codes, and Bookmarks. Choose Never in the Field Shading box. On the Print tab, under Include with Document, be sure there is a check mark next to Drawing Objects, otherwise figures will not print. On the Save tab, you may wish to deselect Allow Fast Saves and Automatic Save Every xx Minutes.

You can toggle the table grid lines on and off by checking or unchecking Gridlines in the Table menu. This setting has no effect on printing. Tables in this document do not contain cell borders.

### **3. Settings in Microsoft Word Viewer**

Click View, Options... and check the following settings. There are several items to inspect on the View tab. Under Nonprinting Characters, deselect all of the options (that is, remove the check marks). Under Show, select Wrap to Window, but deselect Draft Font, Picture Placeholders, Field Codes, and Bookmarks. Choose Never in the Field Shading box. Checking Table Gridlines displays a grid in tables, but has no effect on printing. Tables in this document do not contain cell borders.

## Suggestions for viewing the documentation

On the Print tab, under Include with Document, be sure there is a check mark next to Drawing Objects, otherwise figures will not print.

### 4. Using the table of contents

This file, SFTOC.DOC, contains the master table of contents for the Poisson Superfish documentation. Each individual document file contains its own table of contents pertaining to the material in the file. Within each file, you can double click a page number in the table of contents to jump to that page in the file. In Word Viewer, use a single click. This feature is not available in SFTOC.DOC because of the method used to create the master table of contents.

If you print the entire document, you may wish to discard the separate tables of contents at the beginning of the other files. All the information is included in the master table of contents contained in this file.

### 5. Using the hypertext links

As you read this document on line, you will notice that some text is highlighted in blue. This highlighted text is a hypertext link (or hyperlink) to a location in this documentation that contains more detailed information of the subject. There are two type of links. The links within the same file use a GOTOBUTTON field and are not underlined. A link to another file uses a hyperlink inserted with the Internet Assistant for Microsoft Word. The links that refer to another file are underlined. Links to other files may not work in some older version of Word Viewer. They work in Microsoft Word if you have installed the Internet Assistant, which is available free from Microsoft.

Double-click in Word, or single-click in Word Viewer, in the blue text area to jump to that location. If the section you are jumping to is later in the same document, then the cursor will usually appear at the bottom of the screen. You will need to scroll up a few lines to see the material you are interested in. When jumping to a location earlier in the document, the cursor appears at the top of the screen.

We have included at the start of each file a list of all the bookmarks within the file. You can get to this list by pressing Ctrl-Home to move to the top of the file. Select the topic you are trying to find and click in the highlighted text. The sections on example files often include a link to another file that discusses a feature used in the example. That destination file usually includes a return link to the example. For example, the link in this sentence goes to the [rf-field examples](#), in file SFEXMPL1.DOC, which includes a link to return here.

### 6. Using the Edit, Go To... menu

You can use Go To... in the Edit menu to jump to a specific page number or move forward or backward by some number of pages. Use this method when viewing the table of contents. Bring up the Go To... menu and select Page in the Go To What list on the left. Enter the page number in the text window, then press Go To button on the right.

Another way to use the Go To... dialog box is to jump to a bookmark in the text. The bookmarks correspond to the hypertext links. For convenience, the bookmarks have long,



descriptive names. Scroll through the list, which is sorted alphabetically and when the desired topic appears in the Enter Bookmark Name window, press the Go To button. You can also type in the name of a bookmark if you remember it from past use. Here are some shortcut methods for bringing up the Go To... dialog box:

- Hold down the Ctrl key and then press G, or
- Press the F5 key.

### D. Printing sections of this documentation

You can print directly from Word or Word Viewer, but the pagination may change depending upon the default printer selected on your computer. (Page numbering in this document corresponds to a Hewlett Packard 5Si laser printer.)

Even if you do not print the entire document, we recommend that you print selected sections of the documentation for quick reference. For example, you may wish to print a portion of the Automesh documentation, since this code is the starting point for all Poisson Superfish problems. Most of your data entry will be [REG namelist](#), [PO namelist](#), and [MT namelist](#) variables in Automesh. You may find it helpful to have a list of the problem variables handy in printed form. There are separate alphabetically sorted lists of the [Poisson variables](#) and the [Superfish variables](#).

There are several ways to print material from this document. You can print the entire document, the current page, a range of pages, or material that you highlight by holding down the mouse button and dragging over the text.

#### 1. Printing the entire document

If three-hole paper is available, we recommend using it to save time punching holes in several hundred pages of paper. To print the entire document, open in turn each of the files listed above, Select Print in the File menu, then in the Page range section check the All setting, and click OK.

The first page of each file lists all the bookmarks within the file. Following the bookmarks is a table of contents for the file. The master table of contents in SFTOC.DOC includes all the information from each file's table of contents. These pages may not be useful as part of the printed document and may be discarded.

Page numbers appear centered at the bottom of the page. The first numbered page in each file starts after the file's table of contents. The first page will always be an odd number to accommodate printing on both sides of the page. As a result, the last page of some files may be blank.

##### a. *Margin settings*

We recommend using the default margin settings for US letter size paper of 1.00 inch top and bottom and 1.25 inches left and right. To change or check the margin settings, click File, Page Setup... and go to the Margins tab. We also recommend, if available, using a Hewlett Packard or compatible laser-jet printer. If this is not possible, then before printing anything, you may want to [update the table of contents](#).

### *b. Printing on A4 paper*

If you will be printing on A4 paper, you may want to use the margin settings 1.135 inches (28.8 mm) left and right, 1.00 inch (25.4 mm) top, and 1.69 inches (42.9 mm) bottom. These settings use the same “footprint” as the default settings for US letter paper. The pagination in the document should agree with the table of contents as distributed for most printers with 600-dot-per-inch resolution. Furthermore, tables that span more than one page should print correctly with new headings and titles at the top of continuation pages. Tables and figures that use nearly all of the 6-inch width between left and right margins should not generate error messages about margins from the printer.

### 2. Printing the current page

To print just the page you are viewing, click anywhere in the text to be sure the cursor is in the page you are viewing. Select Print in the File menu, then in the Page range section check the Current setting, and click OK.

### 3. Printing a range of pages

To print a range of pages, use the status bar at the bottom of the screen to identify the page numbers of the starting and ending page you want to print. Also note the section that the pages are in. For example, this paragraph should be in Sec 3. In other files, everything after the table of contents should be in Sec 2. Select Print in the File menu, then in the Page range section click in the data entry window next to Pages. Type “p” and the beginning page number followed immediately by “s” and the section number, then a dash and the ending page and section numbers (for example, p26s2-29s2). Click OK. The Pages selection will be chosen as soon as you start typing the page numbers.

### 4. Printing highlighted material

In the Print dialog box, printing a Selection refers to printing highlighted material. First, while holding down the left mouse button, drag the mouse over the material you wish to print. Release the mouse button. Select Print in the File menu, then in the Page range section check the Selection setting, and click OK.

## **E. Updating the table of contents**

Your printer driver and default printer setup affects the pagination in a document. We recommend using the page layout settings discussed above and a Hewlett Packard or compatible LaserJet printer. If you notice that page numbers in the table of contents do not agree with page numbers printed from the other files, you can update the table of contents in this file. However, this is a somewhat involved process and it requires Microsoft Word. You cannot edit the document using Word Viewer.

Make sure that your default printer is set to the one you will use to print the documentation files. When the default printer is set properly, open each document in turn and note the page number of the last page in the file. As you open the next file in the sequence, place your cursor anywhere in the body of the text after the table of contents, then select Page Numbers... in the Insert menu. (The first few pages of each file are not

## Updating the table of contents

numbered pages. The list of bookmarks and the table of contents are actually in a separate section in the file. This section is for on-line viewing and is not intended to be part of the printed documentation.) In the Page Numbers dialog box, select Format... and add one to the last page in the previous file and type that number in the Start At box. (If you plan to print doubled-sided pages, add one or two as necessary to start each new file on an odd-numbered page.) Click OK twice. Continue this procedure until all the starting page numbers have been updated.

Finally, place the cursor anywhere in the table of contents in this file, press the right mouse button and select Update Field. In the dialog window that appears select Update Entire Table. The update may take several minutes on slower machines. Repeat the Update Field operation for the lists of tables and figures that follow the table of contents. If the dialog window appears for these two updates, select Update Entire Table.

