

Subject Index

A

- Accuracy of HFTs (*see* Error rates/ratios of HFTs)
- Air motion, effect on HFT measurements, 4, 14, 99, 108, 145, 152, 186
- Aluminum
 - carrying case for HFTs, 123
 - jacket for HFTs, 100
 - jacket insulation for pipes, 183
 - support for HFTs, 186
 - use in heat flowmeters/transducers, 177
 - use in HFT installations, 116
 - use in temperature reservoirs, 28
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), 150
- Antenna effect, 241
- Asbestos cement board, laboratory testing, HFTs, 14
- ASTM Standards
 - C 177-76: 4, 68, 151
 - C 236-80: 68
 - C 335-79: 100
 - C 518-76: 68, 129
 - C 976-82: 68
- ASTM Subcommittee C16.30, 3, 4, 30, 254
 - development of standards, 179

B

- Basements (insulated/uninsulated), heat loss, 106

- Belt-type HFTs, 172
- Bibliography, annotated, applications of HFTs, 223-236
- Brick walls, field tests of thermal conductivity, 203
- Bridges, thermal (*see* Thermal bridges)
- Buildings (*see also* Heat flux transducers, use in buildings)
 - calibration of HFTs, 65, 106, 126, 141

C

- Calibration of heat flowmeters, 164
- Calibration of HFTs
 - apparatus for, 27, 81, 131, 247
 - ASTM Committee C-16 on Thermal Insulation, standards development, 254
 - cold plate, 81
 - 1-d method, 245
 - embedded method, 65, 244
 - for use in basements, table, 109
 - for use in building envelope subsystem, walls, roofs, 20, 65
 - for use in house interiors, 126
 - for use on roofs, 65, 131, 250, table, 134
 - for use in soil, table, 109
 - formulas, 26, 34, 37, 73, 84
 - heated foil method, 20
 - hot box, 68, 144, 248
 - hot plate, 4, 68, 81, 247, 254
 - in situ* method, 246
 - "intrinsic calibration value," 80
 - MIT method, 26, 247

Calibration of HFTs (*cont.*)

- MIT versus Hy-Cal Engineering values, table, 38
- National Bureau of Standards method, 25, 109, 131
- radiation enclosure technique, 26, 247
- standardization, 3, 25, 254–256
- workshop on methods, 245
- Cellulose insulation, 129
- Cold plate, use in HFT calibration, 81
- Computer models (*see* Data processing; Finite difference computer models)
- Concrete
 - thermal transmission, 53
 - time lag in HFT measurements, 5
 - use in HFT calibration, 69
- Condensate, steam, heat loss measurements, pipe, 100
- Conductivity, thermal (*see* Thermal conductivity; Thermal transmission)
- Constantan, use in heat flowmeters/transducers, 167, 173
- Contact thermal resistance of heat flux transducers (*see* Thermal resistance, HFT contact)
- Convection, air (*see* Air motion)
- Convective factor, calculation, 73, 146
- Copper, use in heat flowmeters/transducers, 165, 173
- Cover plates, for HFTs, 54–56, 131, 186
- Cycles, diurnal (*see* Diurnal cycles)

D

Data processing

- heat flow ratio: heat flow transducer versus surrounding material, 45

heat flow and temperature data, 141

HFT calibration data, 32, 33, 90

Deflection, heat flow (*see also* Isotherms)

errors in HFT measurements, 79

Distortion, heat flow

embedded HFTs, 45

formula, 47

table, 62

surface-mounted HFTs, 9, 79

Diurnal cycles, effect on thermal

conductivity, 99, 184, 197,

201, 205, 217

E

Edge guarding (*see* Guard frames)

Edge spill, distortion effect on HFT measurements, 11

Electrical efficiency, HFT bimetallic junctions, 176

Electrical noise, pickup by HFTs, 241

Embedded HFTs (*see* Heat flux transducers, embedded)

Energy monitoring (*see* Thermal conductivity; Thermal resistance; Thermal transmission)

Enthalpy, 117

Envelope, building (*see* Buildings; Walls; Roofs)

Environment effects on HFTs, 5, 11, 99, 113, 128, 184, 203

Equations

Fourier's, 46, 207

Laplace, 48

Philip's, 53

R-value, 5, 126, 135, 140, 203, 251

U-value, 203

Error rates/ratios of HFTs

application

in situ, 16, 23, 99, 109, 126, 140, 203, 210–214

laboratory tests, 79, 129, 198
 calibration
in situ applications, 25, 37,
 142-143
 laboratory tests, 79, 142-143,
 248

F

Felt, jacket insulation for pipes, 183
 Fiberglass
 boards, use in HFT calibration,
 107
 insulation
 below-grade use, 108
 roofs, 129, 184
 walls, 203
 Field testing of HFTs
 Army base buildings, 140
 basements of houses, 106
 insulated pipe, 99, 179
 occupied houses, 106, 122
 roof decks, 75
 in soil, 106
 walls of various materials, 203
 Finite difference computer models,
 13, 45, 79
 Foam
 boards, use in HFT calibration,
 107
 insulation, 129
 Foil, heated, calibration of HFTs,
 20
 Fourier's equation, 46, 207

G

Gel toothpaste, use for contact of
 surface-mounted HFTs, 150
 Generic application standards for
 HFTs, 3
 Glass
 calibration of HFTs, 91
 construction of HFTs, 177
 Glass fiber (*see* Fiberglass)

Grease, thermal, 27, 31, 75
 Guard frames
 application of HFTs, 11, 17, 45,
 56-59, 133, 145, 151, 179
 calibration of HFTs, 35, 79, 85,
 89

Gypsum wallboard
 calibration of HFTs, 144
 insulation of basements, 107
 use for laboratory testing, HFTs,
 14

H

Heat flow (*see* Thermal conductiv-
 ity; Thermal transmission)
 Heat flowmeter, technical charac-
 teristics/performance, 166
 Heat flux sensors (*see* Heat flux
 transducers)
 Heat flux transducers (*see also* Heat
 flowmeter; Hy-Cal BI-7 sen-
 sors)
 applications, 9, 65, 87, 99-203,
 239, 250-256
 annotated bibliography, 223-
 236
 problems, table, 3
 available U.S. products, table,
 178
 belt-wrap type, 172
 calibration (*see* Calibration of
 HFTs)
 construction of, 12, 23, 133, 141,
 186, 241, 252
 review, 172
 embedded
 calibration method, 65, 245
 comparison with surface-
 mounted, 142
 roof tests, 251
 error rate of (*see* Error rates/
 ratios of HFTs)
 industrial use, 99, 172, 239-244

Heat flux transducers (*cont.*)

placement diagrams, 72, 74, 124-125, 132, 187

placement methods (*see* Heat flux transducers, embedded, sandwiched, surface-mounted)

residential use, 9, 106, 122, 252

response time, 18, 184, 188, 197, 203

sandwiched, 10

soil corrosion effect, 109

soil heat loss measurement, 106, 114-119

surface-mounted

environmental effects, 4, 45, 65, 99, 251

inside wall, Army base buildings, 140

inside wall, basement, 106

inside walls, occupied houses, 9, 106, 122, 252

intrinsic/extrinsic properties, table, 11

pipes, 99, 179, 239

plywood roof, 184

roofs, 129, 184, 251

thermal conductivity of, 25, 41, 79, 184

walls, 253

use in buildings

basements, 106

below grade, 106, 255

flat plywood deck roof, 184

metal deck roof, 73

metal deck roofs with spray-applied insulation, 129

occupied houses, New Zealand, 122

roofs of various materials, 184, 250

wall surfaces, indoor, 122, 140

walls of various materials, 203, 252

use in houses, 9, 106, 122, 252

use on pipes, 99, 179-183, 239

use on roofs, 5, 73, 129, 184

workshop, 250

use on walls, 203

workshop, 253

Heated foil, calibration of HFTs, 20

HFTs (*see* Heat flux transducers)

Hot box

ASTM Standards

C 236-80:68

C 976-82:68

use in HFT calibration, 68, 144, 248

Hot plate

ASTM Standard C 177-76: 4, 68

use in calibration of

heat flowmeter, 166

HFTs, 4, 68, 81, 247, 254

Houses, use of HFTs

below grade basements, 106

New Zealand home insulation survey, 106

occupied, 9, 122, 252

wood frame construction, 106

Hy-Cal BI-7 sensors, 31

I

Ice water

calibration of HFTs, 27

temperature reservoirs, 29

thermocouple reference, 186

Industrial use of HFTs (*see* Heat flux transducers, industrial use)

Insulating materials, thermal

aluminum, 183, 240

cellulose, 129

felt, 183

fiberglass, 108, 129, 184, 203

foam, 129

gypsum wallboard, 14, 107, 144

industrial use, 99, 129, 179-181, 184

- polyurethane, 129
- residential use, 106, 129, 184
- spray-applied, 129
- use on pipes in geyser fields, 181–183
- “Insulating rug,” HFT errors, 11
- International Thermal Instrument, HFT, 31
- Isotherms
 - embedded HFTs, 51, 55, 143
 - surface-mounted HFTs, 13

J

- Jacket
 - aluminum for HFTs, 100
 - pipe insulation, 183, 240
- Junctions in heat flowmeters
 - coplanar, 163
 - parallel plane, 163

L

- Laminar air flow, calculation of
 - convective heat transfer coefficient, 146–149
- Laplace equation, 48

M

- Masking tape (*see* Tape, masking)
- Masonry walls, thermal transmission, 5, 107, 203
- Massachusetts Institute of Technology (MIT)
 - calibration values of HFTs, 25
- Metal curtain walls, thermal transmission, 5
- Models, computer (*see* Data processing; Finite difference computer models)
- Models, thermal performance, 11, 129, 184
- Moisture, effect on HFTs, 106, 184, 190, 250, 255

N

- National Bureau of Standards, calibration of HFTs, 25, 109, 131
- New Zealand Standards, house insulation, 122
- Nickel, use in heat flowmeters, 165–167
- Noise, electrical, effect on thermocouple signal, 24
- North/south exposure, and below grade building heat loss, 113

O

- n*-Octadecane, temperature reservoirs, 28

P

- Paint
 - absorptivity of HFTs, 150
 - calibration of HFTs, 75
- Perspex, application testing of HFTs, 91
- Philip's equation, 53
- Photoetching, construction of heat flowmeters, 164
- Pipe
 - insulation, 99, 183, 239
 - type/location, HFTs, 172, 239
- Plywood deck roofs, thermal conductance, 184
- Polyimide film, use in heat flowmeters/transducers, 177
- Polystyrene
 - application testing of HFTs, 14
 - calibration of HFTs, 30, 69
 - thermal resistance of HFTs, 27, 30, 69
- Polyurethane insulation, 129

R**Radiation**

- enclosure technique for calibration of HFTs, 26, 36, 247
- heat transfer, 140
- solar, 117, 253

Reservoirs, temperature, 26**Residential use of HFTs (*see* Heat flux transducers, residential use)****Resistance, contact, calibration of HFTs, 17, 27, 42****Resistance, thermal (*see* Thermal resistance)****Response time (*see also* Thermal lag) 18, 35, 184, 188, 197, 203****Roofs**

- concrete deck
 - thermal lag in HFT measurements, 5
 - thermal transmission, 5
 - installation of HFTs, 74, 124
 - metal deck
 - calibration of HFTs, 67, 129
 - thermal transmission, 73
 - plywood, thermal conductivity of, 184
 - spray-applied insulation, 129
 - steel deck
 - thermal lag in HFT measurements, 5
 - thermal transmission, 5
 - workshop on HFT applications, 250
- R-values (*see also* Thermal resistance)**
- formulas, 5, 126, 135, 140, 203, 251
 - insulated pipes in geyser field, table, 183
 - insulated/uninsulated Army base buildings, 140

- insulated/uninsulated walls, 203
- occupied houses, 11, 122
- spray-applied insulating materials, 129

S**Sandwiched HFTs, installation method, 10****Seasonal effects, 102, 103, 113, 116, 128, 184, 201****Sensors, heat (*see* Heat flowmeters; Heat flux transducers)****Silver, in heat flowmeters/transducers, 173****Snow, as ground insulation, 116****Soil, thermal conductivity, 114-119****Spray application of insulation, 129****Standards for HFTs**

- ASTM Subcommittee C16.30, 3, 254
- calibration, 3, 254
- development for applications, 239-256
- National Bureau of Standards, 25, 109, 131

Steel, thermal transmission, 5, 53**Studs, thermal conductivity of walls, 210****Styrofoam****application testing of heat flux transducers, 91****use for thermal resistance, 27, 29****Surface air motion (*see* Air motion)****Surface mounting of HFTs (*see* Heat flux transducers, surface-mounted)****T****Tape, masking, absorptivity of, 150****Tellurium, in heat flowmeters/transducers, 173**

- Temperature
 - air, 15, 71, 99, 115, 184, 203
 - ambient and HFT measurements,
 - table, 103, 104, 134-136
 - dependence of HFT signal, 105
 - ground surface, 115
 - HFT surface, 56
 - indoor, 127, 203
 - insulation, 184
 - pipe
 - surface, 99
 - temperature versus heat flow,
 - table, 183
 - soil, 118
 - substrate surface, 71
 - wall surface, 108, 203
 - Temperature reservoirs, 26
 - Thermal bridges, 123, 133, 205
 - Thermal conductivity (*see also* Thermal transmission; U-value)
 - fiberglass, 131, 184
 - flat roofs, 184
 - formulas, 184
 - of HFTs, 41, 45, 53, 79, 87, 142
 - plywood in roofs, 184
 - ratio, slope, and transfer function calculation methods, 184
 - soil, 114
 - various materials, 87, 129, 144
 - table, 53, 210
 - Thermal efficiency of HFTs, 176
 - Thermal insulating materials (*see* Insulating materials, thermal)
 - Thermal lag, HFTs, 18, 184, 188, 197, 203
 - table, 5
 - Thermal resistance (*see also* R-values)
 - cellulose, table, 136
 - fiberglass, table, 136
 - HFT contact, 87, 151
 - polystyrene, 27
 - polyurethane, table, 135
 - Styrofoam, 27
 - Thermal transmission (*see also* Thermal conductivity; Thermal resistance)
 - ASTM Standards
 - C 177-76, 68
 - C 236-80, 68
 - C 518-76, 68
 - C 976-82, 68
 - calibration of HFTs, 68
 - metal curtain walls, 5
 - metal roof decks, 73
 - occupied houses, 11, 106, 122
 - Thermocouples (*see also* Heat flux transducers, construction of)
 - soil temperature measurement, 108
 - thermal conductivity, roof, 184
 - Thermopiles, Gier-Dunkle, 173
 - Thickness of heat flowmeters/transducers, 164, 177 (*see also* Heat flux transducers, construction of)
 - Transfer function, in thermal conductivity measurements, 184
 - Turbulent air flow, effect on convective heat transfer coefficients, 146-149
- U**
- U-value
 - formula, 203
 - insulated/uninsulated walls, 203
- V**
- Vapor transport, soil, 106, 115, 117
- W**
- Walls
 - brick, field tests of thermal conductivity, 203

Walls (*cont.*)

- effect of material on heat flux transducer error ratios, 87
- gypsum wallboard, calibration of HFTs, 144
- heat capacity, 87
- installation of HFTs, 124–125
- masonry
 - field tests of thermal conductivity, 203
 - heat loss, 5, 107, 203
 - thermal lag in HFT measurements, 5
 - thermal transmission, 5
- metal curtain
 - thermal lag in HFT measurements, 5
 - thermal transmission, 5

wood cavity

- thermal lag in HFT measurements, 5
- thermal transmission, 5, 140
- workshop on HFT applications, 252

Weather (*see* Seasonal effects)**Wind (*see also* Air motion)**

- effect on HFT measurements, 101

Winter, effects on heat flow, 116, 128, 201**Wood walls, thermal transmission, 5, 140****Wraparound HFTs, 172****Z****Zero offset, HFTs, 241, 248**