



ENHANCED FUJITA SCALE DAMAGE INDICATORS AND DEGREES OF DAMAGE

List of 31 Damage Indicators (Canadian DIs prefaced with 'C')

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All wind speeds in km/h

1. SMALL BARNs OR FARM OUTBUILDINGS (SBO)

Typical Construction:

- Less than 250 m²
- Wood or metal post and beam construction
- Wood or metal roof trusses
- Wood or metal panel siding
- Metal or wood roof
- Large doors

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	100	85	126
2	Loss of wood or metal roof panels	119	98	146
3	Collapse of doors	134	109	164
4	Major loss of roof panels	145	126	177
5	Uplift or collapse of roof structure	150	124	183
6	Collapse of walls	156	130	192
7	Overturning or sliding of entire structure	159	134	190
8	Total destruction of building	180	151	211

2. ONE- OR TWO-FAMILY RESIDENCES: 100 - 500 m² (FR12)

Typical Construction:

- Asphalt shingles, tile, slate or metal roof covering
- Flat, gable, hip, mansard or mono-sloped roof or combinations thereof
- Plywood/OSB or wood plank roof deck
- Prefabricated wood trusses or wood joist and rafter construction
- Brick veneer, wood panels, stucco, EIFS, vinyl or metal siding
- Wood or metal stud walls, concrete

Notes:

- With hip roof, use upper bound wind speed for DOD4 and DOD6

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	85	129
2	Loss of roof covering material (less than 20%), gutters and/or awning; loss of vinyl or metal siding	127	101	156
3	Broken glass in doors and windows	154	127	183
4	Uplift of roof deck and loss of significant roof covering material (20% or more); collapse of chimney; garage doors collapse inward; failure of porch or carport	156	130	187
5	Entire house shifts off foundation	195	166	227
6	Large sections of roof structure removed; most walls remain standing	196	167	229
7	Exterior walls collapsed	212	182	246
8	Most walls collapsed, except small interior rooms	245	204	286
9	All walls collapsed	274	229	319
10	Destruction of engineered and/or well-constructed residence; slab swept clean	322	266	354

3. MANUFACTURED HOMES: SINGLE WIDE (MHSW)

Typical Construction:

- Steel undercarriage supported on concrete block piers
- Metal straps and ground anchors (frame and/or over-the-top strap anchors)
- Asphalt shingles or one-piece metal roof covering
- Wood roof joists; metal, vinyl or wood siding
- Wood stud walls and partitions

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	98	82	122
2	Loss of shingles or partial uplift of one-piece metal roof covering	119	98	148
3	Unit slides off block piers but remains upright	140	116	166
4	Complete uplift of roof; most walls remain standing	143	117	180
5	Unit rolls on its side or upside down; remains essentially intact	158	135	183
6	Destruction of roof and walls leaving floor and undercarriage in place	169	140	198
7	Unit rolls or vaults; roof and walls separate from floor and undercarriage	175	154	206
8	Undercarriage separates from unit; rolls, tumbles and is badly bent	190	163	219
9	Complete destruction of unit; debris blown away	204	177	238

4. MANUFACTURED HOMES: DOUBLE WIDE (MHDW)

Typical Construction:

- Steel undercarriage supported on concrete block piers
- Multi-unit connection at roof, floor and end walls
- Frame straps and ground anchors spaced 3 - 4 m apart
- Flat, gable or hip roof shape; asphalt shingles or metal roof panels; plywood/OSB roof decking; wood rafter or shallow joist construction; metal, vinyl or wood siding

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	98	82	122
2	Loss of shingles or other roof covering (less than 20%)	122	100	142
3	Damaged porches or carports	126	108	154
4	Broken windows	134	109	153
5	Uplift of roof deck and loss of significant roof covering material (20% or more)	142	121	174
6	Complete uplift of roof; most walls remain standing	150	124	177
7	Unit slides off CMU block piers	151	126	175
8	Removal of entire roof structure leaving most walls standing	156	129	188
9	Complete destruction of roof and walls leaving undercarriage in place	182	150	211
10	Unit rolls, displaces or vaults	183	132	209
11	Undercarriage separates from floor, rolls and tumbles, badly bent	204	175	233
12	Complete destruction of unit; debris blows away	216	192	248

5. APARTMENTS, CONDOMINIUMS AND TOWNHOUSES: 3 STOREYS OR LESS (ACT)

Typical Construction:

- Flat, gable, hip or mansard roof
- Asphalt shingles, tile, metal or BUR roof covering
- Plywood/OSB roof decking
- Light-framed wood or metal roof trusses
- Wood, metal or vinyl panels, stucco brick veneer or EIFS wall covering; combinations of wall coverings
- Wood or metal stud walls; wood floor diaphragms
- Sliding patio doors; balconies

Notes:

- With hip roof, use upper bound wind speed for DOD3 and DOD4

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	122	101	153
2	Loss of roof covering (less than 20%)	159	132	195
3	Uplift of roof decking; significant loss of roof covering (20% or more)	200	172	235
4	Uplift or collapse of roof structure leaving most walls standing	222	193	254
5	Most top story walls collapsed	254	222	296
6	Almost total destruction of top two stories	290	249	330

6. MOTELS (M)

Typical Construction:

- Less than or equal to four storeys
- Facility made up of one or more multi-storey, rectangular buildings
- Flat, gable, hip or mansard roof
- Asphalt shingles, tile, slate or BUR roof covering
- Plywood/OSB roof decking, wood or metal prefabricated roof trusses
- Wood floor diaphragms, wood or metal stud walls
- Stucco, EIFS, wood, metal or brick veneer wall cladding
- Canopy over driveway at entrance; exterior walkways or balconies

Notes:

- With hip roof, use upper bound wind speed for DOD4 and DOD6

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	106	87	134
2	Loss of roof covering (less than 20%)	129	108	159
3	Broken windows or patio doors	143	119	172
4	Uplift of roof decking; significant loss of roof covering (20% or more); loss of EIFS wall cladding	153	129	187
5	Uplift or collapse of canopy over driveway	159	130	190
6	Uplift or collapse of roof structure leaving most walls standing	198	166	230
7	Collapse of top story exterior walls	222	195	251
8	Collapse of most top story walls	230	204	261
9	Collapse of top two floors of three or more stories	274	232	298
10	Total destruction of entire building	306	262	349

7. MASONRY APARTMENTS OR MOTELS (MAM)

Typical Construction:

- Less than or equal to four storeys
- Facility made up of one or more multi-storey, rectangular buildings
- Flat, gable, hip or mansard roof
- Asphalt shingles, tile, slate or BUR roof
- Light steel roof framing with metal deck and lightweight insulation
- Pre-cast or hollow-core concrete roof and floor system
- CMU non-bearing walls
- CMU load-bearing walls
- Stucco, EIFS, or brick veneer wall cladding
- Exterior walkways or balconies

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	87	130
2	Loss of roof covering (less than 20%)	129	108	163
3	Uplift of lightweight metal roof decking	153	130	187
4	Uplift of concrete roof decking	195	166	230
5	Collapse of top storey walls	214	185	241
6	Collapse of top two floors of three or more storeys	251	212	290
7	Total destruction of a large section of building	290	257	330

8. SMALL RETAIL BUILDINGS (SRB)

Typical Construction:

- Best example is fast-food restaurant
- Flat, hip, gable, mansard or mono-slope roof
- Asphalt shingles, metal panels, slate, tile, single-ply or BUR roof covering
- Plywood/OSB roof decking
- Wood or metal roof structure consisting of trusses or rafters and joists
- Wood or metal stud walls
- Typically have large areas of window glass and double entry doors
- Canopies, covered walkways or porches
- Wood, brick veneer, metal or vinyl siding, concrete blocks, EIFS or stucco wall cladding

Notes:

- With hip roof, use upper bound wind speed for DOD4 and DOD6

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	87	130
2	Loss of roof covering (less than 20%)	126	105	158
3	Broken glass in windows and doors	138	116	166
4	Uplift of roof decking; significant loss of roof covering (20% or more)	158	130	192
5	Canopies or covered walkways destroyed	158	134	183
6	Uplift or collapse of entire roof structure	192	163	225
7	Collapse of exterior walls; closely spaced interior walls remain standing	222	193	256
8	Total destruction of entire building	269	230	311

9. SMALL PROFESSIONAL BUILDINGS: SINGLE STOREY, LESS THAN 500 m² (SPB)

Typical Construction:

- Flat, gable, hip, mansard or mono-slope roofs with or without parapet walls
- Asphalt shingles, tile, slate, metal panels, single-ply or built-up roof covering
- Light-frame steel construction, steel joists and formed metal decking
- Load-bearing masonry construction with steel or wood roof structure
- Timber post and beam construction
- Wood or metal stud walls, non-bearing masonry walls
- Metal or vinyl panels, stucco or EIFS cladding
- Skylights and/or clearstories

Notes:

- With hip roof, use upper bound wind speed for DOD5 and DOD7

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	87	130
2	Loss of roof covering (less than 20%)	126	105	158
3	Broken windows, including clear story windows or skylights	143	119	172
4	Exterior doors fail	161	132	190
5	Uplift of roof decking; significant loss of roof covering (20% or more); loss of rooftop HVAC equipment	161	135	188
6	Collapsed façade or parapet walls	166	137	198
7	Uplift or collapse of entire roof structure	200	169	233
8	Collapse of exterior walls; closely spaced interior walls remain standing	232	198	266
9	Total destruction of entire building	253	238	322

10. STRIP MALLS (SM)

Typical Construction:

- Large, rectangular single-storey building with large surrounding parking lots
- Flat roof with parapet wall
- Built-up roofing or single-ply roof membrane with rigid insulation
- Wood or metal deck, wood-fiber cement panels
- Light-frame steel roof support with steel joists or joist girders
- Brick or concrete block wall construction
- Large window glass and glass entry doors
- Covered walkway attached to building

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	87	130
2	Uplift of roof covering at eaves and roof corners	129	106	161
3	Broken windows or glass doors	142	116	169
4	Uplift of roof decking	163	135	196
5	Collapsed façade or parapet walls	166	137	201
6	Covered walkways uplifted or collapsed	166	138	201
7	Uplift or collapse of entire roof structure	196	166	230
8	Collapse of exterior walls; closely spaced interior walls remain standing	225	188	266
9	Complete destruction of all or a large section of building	275	237	319

11. LARGE SHOPPING MALLS (LSM)

Typical Construction:

- Typically one or two storeys
- Flat roof; some areas with relatively large spans
- Skylights and clear stories
- Single-ply or BUR with or without roof gravel
- Metal stud walls with brick veneer, stucco or EIFS cladding
- Light steel structural framing with open web joists, light metal framing or 3-D space framing
- Glass at entries

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	114	95	138
2	Loss of roof covering (less than 20%)	137	111	169
3	Broken skylights, clearstory windows and atrium walls broken	148	121	183
4	Uplift of some roof decking; significant loss of roofing material (20% or more); loss of rooftop HVAC	174	148	206
5	Wall cladding stripped starting at corners and progressing to other areas	179	151	211
6	Roof structure uplifted or collapsed	206	174	241
7	Exterior walls in top storey collapsed	232	200	267
8	Interior walls of top storey collapse	257	224	298
9	Complete destruction of all or a large section of the building	328	283	398

12. LARGE ISOLATED RETAIL BUILDINGS (LIRB)

Typical Construction:

- Flat roof with BUR and gravel or single-ply membrane roof; generally has a 1m parapet
- Open web joists and steel girders or joist girders supported by tall pipe columns
- Metal deck with rigid insulation or lightweight concrete fill slab
- Large windows on front side of building
- CMU walls, tilt-up concrete panels, metal stud walls covered with EIFS or combinations of these

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	109	92	134
2	Loss of roof covering (less than 20%)	130	109	166
3	Uplift of some roof decking; significant loss of roofing material (20% or more); loss of rooftop HVAC	166	140	198
4	Long roof spans collapsed downward	196	166	232
5	Uplift and removal of roof structure	216	183	253
6	Inward or outward collapse of exterior walls	220	190	254
7	Complete destruction of all or a large section of the building	278	237	323

13. AUTOMOBILE SHOWROOMS (ASR)

Typical Construction:

- Most showrooms are single-storey buildings with flat roof
- Roof system is BUR or single-ply membrane
- Metal roof deck or plywood panels
- Steel structural framing with open web steel joists
- Metal stud walls with EIFS, stucco or tilt-up panels
- Exterior walls on 2 or 3 sides have large glass windows

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	76	129
2	Loss of roof covering (less than 20%)	129	108	163
3	Broken glass in windows or doors	140	114	171
4	Uplift of some roof decking; significant loss of roofing material (20% or more); loss of rooftop HVAC	163	134	193
5	Cladding stripped off walls	180	151	212
6	Uplift or collapse of roof structure	190	158	225
7	Exterior walls collapsed	203	171	238
8	Complete destruction of all or a large section of the building	253	222	291

14. AUTOMOBILE SERVICE BUILDINGS (ASB)

Typical Construction:

- Single storey building with flat roof and relatively tall walls with parapet
- Roof coverings are typically BUR with gravel or single-ply membrane
- Roof structure is light steel framing or open web steel joists and metal roof deck
- Exterior walls are concrete masonry or pre-cast tilt-up panels
- Numerous large metal overhead doors

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	101	74	127
2	Loss of roof covering (less than 20%)	126	105	159
3	Failure of large overhead doors	146	124	177
4	Uplift of some roof decking; significant loss of roofing material (20% or more); loss of rooftop HVAC	158	129	192
5	Collapse of non-bearing masonry or tilt-up walls	183	151	216
6	Uplift or collapse of roof structure	195	164	230
7	Collapse of load-bearing walls	206	171	240
8	Complete destruction of all or a large section of the building	253	222	291

15. ELEMENTARY SCHOOLS (ES)

Typical Construction:

- These buildings are typically single storey with flat roofs; CMU bearing walls with brick veneer, stucco or EIFS cladding; walls can have a large percentage of window glass
- Building may contain a small gym or cafeteria with moderately long spans between supports
- Buildings have long interior hallways with bearing or non-bearing walls
- BUR, single-ply membrane or metal standing seam roof panels; metal or plywood roof decking supporting rigid insulation boards or a lightweight poured gypsum deck
- Roof structure consists of open web steel joists bearing on exterior walls and steel interior girders; exterior non-bearing walls constructed with CMUs, glass curtain walls or metal studs with brick veneer, stucco or EIFS cladding

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	76	129
2	Loss of roof covering (less than 20%)	127	106	159
3	Broken windows	140	114	171
4	Exterior door failures	159	137	190
5	Uplift of some roof decking; significant loss of roofing material (20% or more); loss of rooftop HVAC	163	132	195
6	Damage to or loss of wall cladding	174	148	204
7	Uplift or collapse of roof structure	201	174	238
8	Collapse of non-bearing walls	224	188	261
9	Collapse of load-bearing walls	246	209	290
10	Total destruction of a large section of or entire building	283	245	327

16. JUNIOR OR SENIOR HIGH SCHOOLS (JHSH)

Typical Construction:

- Generally large one or two-storey buildings with flat roofs; may contain gymnasiums, cafeteria and auditorium with large structural spans; may have a basement
- Classroom wings have interior hallways with bearing or non-bearing interior walls
- BUR or single-ply membrane roof covering with or without gravel; structural system may consist of an all steel structure or an all reinforced concrete structure or a combination of both
- Roof structure may be light steel construction with open web joists supported on steel beams; corrugated metal roof deck with rigid insulation or poured gypsum deck
- Exterior walls constructed of concrete or clay blocks with brick veneer, stucco or EIFS; metal and glass curtain walls; walls may have more than 30% windows

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	109	89	134
2	Loss of roof covering (less than 20%)	127	106	159
3	Broken windows	140	114	171
4	Exterior door failures	163	134	195
5	Uplift of metal roof decking; significant loss of roofing material (20% or more); loss of rooftop HVAC	163	137	192
6	Damage to or loss of wall cladding	174	148	204
7	Collapse of tall masonry walls at gym, cafeteria or auditorium	183	151	219
8	Uplift or collapse of light steel roof structure	201	174	238
9	Collapse of exterior walls in top floor	224	195	246
10	Most interior walls of top floor collapsed	254	214	299
11	Complete destruction of all or a large section of building	309	262	360

17. LOW-RISE BUILDINGS: 1 - 4 STOREYS (LRB)

Typical Construction:

- Generally consist of rectangular modules but can be “odd shaped” in plan
- Most will have flat roofs but can have gable, hip or mansard shapes
- Roofing materials include BUR, single-ply membrane, metal panels or standing seam
- Roof deck is wood or metal deck, poured gypsum deck or concrete slab
- Steel or reinforced concrete structural frame
- Glass and metal curtain walls, metal studs with EIFS, non-bearing masonry walls with stucco or brick veneer
- Examples are office buildings, medical facilities, and bank buildings

Notes:

- With hip roof, use upper bound wind speed for DOD3 and DOD5

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	109	89	134
2	Loss of roof covering (less than 20%)	129	108	166
3	Uplift of metal roof decking at eaves and roof corners: significant loss of roofing material (20% or more)	163	134	193
4	Broken glass in windows, entryways or atriums	163	134	196
5	Uplift of lightweight roof structure	214	183	253
6	Significant damage to exterior walls and some interior walls	230	196	269
7	Complete destruction of all or a large section of building	303	259	356

18. MID-RISE BUILDINGS: 5 - 20 STOREYS (MRB)

Typical Construction:

- Generally consist of rectangular shapes but can have curved or triangular footprints
- Roofs are generally flat; may have an elevator/mechanical penthouse; parapet walls
- Structural frame is steel or reinforced concrete
- Roofing materials are BUR or single-ply membrane with or without gravel
- Penthouse is steel framing with metal panels, or metal studs with stucco or EIFS
- Exterior cladding is glass or metal curtain walls; pre-cast concrete window wall panels or a combination of the two
- Roof structure consists of metal deck, poured gypsum deck or concrete slab
- Examples are office buildings, medical facilities, and residential buildings

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	113	93	138
2	Loss of roof covering (less than 20%)	134	109	166
3	Damage to penthouse roof and walls; loss of rooftop HVAC equipment	148	121	182
4	Damage to parapet walls or coping	159	134	190
5	Broken glass in curtain walls; glass in entryways; significant damage to building interior	163	134	193
6	Uplift of lightweight roof decking; significant loss of roofing material (20% or more)	192	158	225
7	Broken curtain wall panel anchors	208	177	241
8	Uplift or collapse of roof structure	219	190	254
9	Significant damage to curtain walls and some interior walls	233	193	269
10	Permanent structural deformation	338	291	431

19. HIGH-RISE BUILDINGS: GREATER THAN 20 STOREYS (HRB)

Typical Construction:

- Generally consist of rectangular shapes but can have curved or triangle footprints
- Roofs are generally flat but may have a more complex roof shape as part of aesthetic statement; roofing material single-ply membrane fully adhered, polyurethane foam roof, metal or copper clad roof covering
- Structural frame is steel or reinforced concrete; penthouse is steel framing with metal panels
- Exterior cladding is glass or metal curtain walls or pre-cast concrete window panels
- First floor often has very large glass areas that are susceptible to debris impact
- Atriums with overhead glazing or tall window walls
- Examples are hotels, office buildings, and condominiums

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	113	93	138
2	Loss of roof covering (less than 20%)	138	111	172
3	Damage to penthouse roof and walls; loss of rooftop HVAC equipment	150	121	179
4	Broken glass in exterior walls at 1st and 2nd floors; broken glass in entryways	163	134	193
5	Damage to parapet walls or coping	167	140	196
6	Broken curtain wall panel anchors	208	177	253
7	Significant loss of roofing material (20% or more)	230	185	266
8	Significant damage to curtain walls and interior walls	233	198	277
9	Uplift or collapse of roof structure	256	198	295
10	Permanent structural deformation	367	306	467

20. INSTITUTIONAL BUILDINGS (IB)

Typical Construction:

- Examples are hospitals, courthouses, university buildings, state and federal buildings, jails
- Range in height from 1 – 10 storeys; balconies, porches and porticos with heavy façade
- Roofing materials include fully adhered and mechanically fastened single-ply membranes, polyurethane foam, copper-clad domes
- Structure is normally reinforced concrete, relatively small windows
- Walls are masonry with cut stone or pre-cast panels – very ornate

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	116	95	142
2	Loss of roof covering (less than 20%)	138	116	175
3	Damage to penthouse roof and walls; loss of rooftop HVAC equipment	148	121	179
4	Broken glass in windows or doors	153	126	185
5	Uplift of lightweight roof deck and insulation; significant loss of roofing material (20% or more)	183	153	219
6	Façade components torn from structure	190	156	225
7	Damage curtain walls or other wall cladding	211	177	245
8	Uplift of pre-cast concrete roof slabs	229	192	262
9	Uplift of metal deck with concrete fill slab	235	190	274
10	Collapse of some top story exterior walls	238	204	277
11	Complete destruction of all or a large portion of building	338	286	431

21. METAL BUILDING SYSTEMS (MBS)

Typical Construction:

- Examples are warehouses, industrial facilities, small arenas
- Metal panel walls and standing seam roof
- Nearly always have a gable roof and relatively tall walls
- Large overhead doors
- Large-span single bay rigid frames
- Z- or C-shaped purlins and girts span between rigid frames
- Lateral loads resisted by cross-bracing

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	108	87	134
2	Inward or outward collapse of overhead doors	143	121	174
3	Metal roof or wall panels pulled from the building	153	126	193
4	Column anchorage failed	188	154	217
5	Buckling of roof purlins	190	153	222
6	Failure of cross-braces in the lateral load resisting system	222	190	254
7	Progressive collapse of rigid frames	230	193	270
8	Total destruction of building	249	212	286

22. SERVICE STATION CANOPIES (SSC)

Typical Construction:

- Modern service stations consist of a very large canopy covering the entire pump area and a small building that houses cashier and retail space
- Canopy structure constructed of steel beam framework supported on 4 or more tall columns
- Metal panels cover bottom side of the canopy
- Light weight fascia materials, either metal or plastic, cover the perimeter of canopy

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	101	72	127
2	Fascia material blown from canopy	126	103	154
3	Metal roof panels stripped from canopy	148	119	182
4	Columns bend or buckle under wind load	175	142	217
5	Canopy collapsed due to column foundation failure	183	145	232
6	Complete destruction of canopy	214	177	262

23. WAREHOUSE BUILDINGS (WHB)

Typical Construction:

- This category includes all building systems except Metal Building Systems
- Examples include warehouse, storage and industrial buildings
- Buildings are generally rectangular in plan with flat, gable or hip roofs
- Built-up roofs with gravel, single-ply membrane ballasted, mechanically attached or fully adhered
- Light-frame steel construction with masonry bearing walls
- Large overhead doors
- Pre-cast concrete columns, beams and double tees with tilt-up wall panels
- Heavy timber construction with stud walls and wood panels

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	109	89	134
2	Loss of roofing material (less than 20%)	134	111	169
3	Inward or outward collapse of overhead doors	142	121	172
4	Uplift of roof deck; significant loss of roofing material (20% or more); loss of rooftop HVAC equipment	166	142	196
5	Collapse of other non-bearing exterior walls	183	150	203
6	Collapse of pre-cast concrete tilt-up panels	200	164	232
7	Total destruction of a large section of building or entire building	254	211	299

25. FREE-STANDING TOWERS (FST)

Typical Construction:

- Cell phone pole or tower
- Microwave tower

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	148	122	182
2	Collapsed cell-phone pole or tower	214	182	253
3	Collapsed micro-wave tower	219	187	257

26. FREE-STANDING LIGHT POLES, LUMINARY POLES, FLAG POLES (FSP)

Typical Construction:

- Cantilevered metal pole

DOD	Damage description	EXP	LB	UB
1	Threshold of visible damage	130	108	161
2	Bent pole	164	137	193
3	Collapsed pole	190	159	222

C-1. ELECTRICAL TRANSMISSION LINES (C-ETL)

Typical Construction:

- Single wood poles with wood cross arms, 7-35 m in height and 15-60 cm in diameter (at 2 m above ground)
- Single steel or concrete poles with metal cross arms
- Metal trussed towers

Notes:

- Whether poles go down is related to size, composition (wood / concrete / steel) and load (wire tension, number of transformers)
- For small diameter (~15-20 cm) or very old wood poles, use lower bound; for large diameter (~45-60 cm) wood poles, use upper bound
- Keep in mind – one weak or overloaded pole going down can cause other poles along the line to break due to wire tension
- Trees falling on lines can bring down poles – *do not use this DI if this is the case*
- Metal trussed towers where lines change direction are often more strongly reinforced, use upper bound

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	130	110	155
2	Broken wood cross member	155	125	175
3	Wood poles leaning	175	135	200
4	Broken wood poles	195	145	220
5	Broken or bent steel or concrete poles	210	180	240
6	Collapsed metal truss towers	220	185	255

C-2. TREES (C-T)

Typical Species:

- Hardwood: Oak, Maple, Birch, Ash, Beech, Cherry, Hickory, Walnut, Aspen, Elm, Poplar
- Softwood: Pine, Spruce, Fir, Hemlock, Cedar, Larch, Redwood, Cypress

Notes:

- General differences in the responses of softwood and hardwood species are less important than other factors
- Use lower bound wind speed if trees show evidence of significant rot, or if uprooting occurs with saturated ground or very shallow soil
- In urban and suburban areas, trees broken at the base of the trunk were likely planted too deeply, had mechanical injury, or had girdling roots – use lower-bound wind speed
- Forests and woodlots composed of even-aged monoculture plantations can be assigned a lower-bound wind speed; forests or woodlots composed of mature, deep-rooted red oak, red maple, beech, hemlock or white cedar can be assigned a higher-bound wind speed

DOD	Damage Description	EXP	LB	UB
1	Small limbs broken (less than 2 cm diameter)	70	55	85
2	Large branches broken (2 - 8 cm diameter)	90	65	110
3	Intermittent mature trees snapped and/or uprooted	125	80	160
4	Numerous mature trees snapped and/or uprooted	155	100	190
5	Most mature trees snapped and/or uprooted	180	120	220
6	Virtually all mature trees snapped and/or uprooted, trees may be denuded/debarked by missiles with only stubs of largest branches remaining	230	180	275

C-3. HERITAGE CHURCHES (C-HC)

Typical Construction:

- Built with bricks and/or stones
- Solidly built roof structure
- May also have one or more bell towers

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	80	60	100
2	Loss of roof covering material (less than 20%)	110	85	135
3	Loss of significant roof covering material (20 - 45%); light damage on the bell-tower summit	145	115	175
4	Large sections of roof structure removed (50 - 75%); collapse of the bell-tower summit (spire); walls remain standing	185	150	220
5	Roof structure significantly removed (80% or more) and blown away; walls partly collapsed; bell-tower structure damaged	225	190	260
6	Roof structure totally removed; many walls collapsed; bell-tower structure mostly destroyed	270	230	310
7	Complete destruction of building	315	275	355

C-4. SOLID MASONRY HOUSES (C-SMH)

Typical Construction:

- Asphalt shingles, tile, slate or metal roof covering
- Flat, gable, hip, mansard or mono-sloped roof or combinations thereof
- Plywood/OSB or wood plank roof deck
- All exterior walls are solid masonry construction (e.g. double brick)
- Roof is wood joist and rafter construction

DOD	Damage Description	EXP	LB	UB
1	Threshold of visible damage	105	85	129
2	Loss of roof covering material (less than 20%), gutters and/or awning; loss of vinyl or metal siding	127	101	156
3	Broken glass in doors and windows	154	127	183
4	Uplift of roof deck and loss of significant roof covering material (20% or more); collapse of chimney; garage doors collapse inward; failure of porch or carport	156	130	187
5	Large sections of roof structure removed; most walls remain standing	196	167	238
6	Exterior walls collapsed	245	210	286
7	Most walls collapsed, except small interior rooms	285	247	325
8	Complete destruction of building	315	275	355

C-5. FARM SILOS OR GRAIN BINS (C-FSGB)

Typical Construction:

Farm silos

- Cylindrical structures typically 4 - 10 m in diameter and 20 - 50 m in height
- Construction is wood staves, concrete staves, cast concrete, poured concrete or steel panels

Grain bins

- Cylindrical structures typically 5 - 20 m in diameter and 5 - 30 m in height
- Construction is galvanized steel panels and purlins

DOD	Damage Description	EXP	LB	UB
1	Empty unanchored grain bin toppled; anchored grain bin damaged; silo cap damaged	90	70	110
2	Empty unanchored grain bin rolled or carried through air less than 10 m; anchored grain bin toppled; silo cap removed	135	110	160
3	Anchored grain bin rolled or carried less than 10 m; empty portions of stave concrete silos destroyed	180	150	210
4	Grain bin carried 10 - 100 m or more; stave concrete silo destroyed	225	190	260

C-6. SHEDS, FENCES OR LAWN FURNITURE (C-SFLF)

Typical Construction:

Shed

- Single storey and less than 12 m²
- Wood, metal and/or plastic construction
- Metal, wood, plastic or shingle roof
- May have wood, metal or vinyl siding
- May have one or more windows
- May be unanchored or weakly anchored

Wood fence

- Wood rails, panels and posts (sunk into post holes)

Lawn Furniture

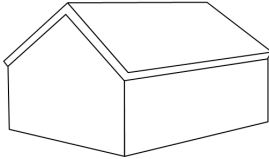
- Light wood, metal and/or plastic construction intended for outdoor use

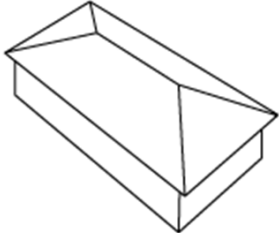
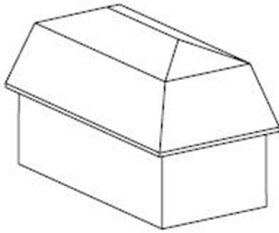
Notes:

- Use upper bound wind speed for large and/or well-anchored sheds

DOD	Damage Description	EXP	LB	UB
1	Garden shed overturned, wood fence blown down, lawn furniture blown around	90	70	110
2	Garden shed rolled or carried through the air less than 10 m, lawn furniture carried through air	135	110	160
3	Garden shed carried through air 10 m or more	180	150	210

GLOSSARY

BUR roof covering	Built Up Roof covering is a continuous, semi-flexible membrane consisting of plies of saturated felts, coated felts, fabric or mats assembled with alternate layers of bitumen and surfaced with mineral aggregate, bituminous material or granule surface sheets.
Clerestory	A pronounced high wall with a band of windows along the top. It usually rises above an adjoining roof.
CMU walls	Concrete Masonry Unit walls are forms of portland cement and aggregates made to various shapes, typically 20 cm high by 40 cm wide. CMUs can be either normal or heavy weight for load-bearing conditions. Light weight units are intended for non load-bearing conditions such as veneers.
DOD	Degree of Damage
EIFS	Exterior Insulation and Finish Systems are multi-layered exterior wall systems built for commercial and residential buildings. EIFS consists of insulation board secured to the exterior wall surface by adhesive or mechanical attachment. There is a water-resistant base coat applied on top of the insulation and reinforced with fiber glass mesh. There is a finish coat applied to the exterior.
EXP	Expected value for 3-second gust wind speed at 10 m in flat, uniform, open terrain
Floor Diaphragm	A wood frame floor system consisting of joists, sheathing overlaid on joists, rim joists. Studs below provide a load path to the rim joists. Building codes may only require floor diaphragms to be fastened along continuously supported panel edges, often called an unblocked diaphragm. A fully blocked diaphragm means that each panel segment edge not on a joist is supported by a block.
Gable roof	A roof having two sloping sides that come together at a ridge, creating end walls with a triangular extension, called a gable, at the top 
Girt	A secondary horizontal structural member attached to sidewall or endwall columns to which a wall covering may be attached.

Hip roof	A roof that slopes back from all four sides to a single point, or line, at the top 
HVAC	Heating, Ventilation and Air-Conditioning
ICF	Insulating Concrete Forms are used with poured concrete to produce permanent walls. Forms are made of foam insulation and a steel frame. Concrete occupies the interior of the form. ICF panels are connected with plastic ties.
LB	Lower Bound value for 3-second gust wind speed at 10 m in flat, uniform, open terrain
Mansard roof	A type of hip roof where each sloping section is divided in two to create maximum space under the roof; the first section near the walls rises steeply while the second section continues at a milder pitch toward the center. 
Open web joist	A structural system designed to bear loads with a minimum of mass. It consists of structural wood top and bottom chords or steel tube webs with interconnecting pins.
OSB	Oriented Strand Board, similar to plywood but uniform and cheaper. A manufactured 4' X 8' wood panel made up of 1" - 2" wood chips and glue.
Parapet wall	A low wall or railing along the edge of a platform, terrace or roof.
Polyurethane foam roof	Roof decking is sprayed with an elastic, closed-cell foam and then covered with an additional coating. The final cover is several inches thick.
Poured gypsum roof deck	A gypsum concrete roof deck consisting of gypsum concrete that is mixed with either wood fibers or mineral aggregate.

Purlins	Channel-shaped steel structures used to span roof trusses of metal buildings and serve to support the roof deck. Common Purlins come in Z and C shapes.
Single-ply membrane roof	Consists of a single waterproof membrane laid on a roof deck and attached by mechanical or adhesive fastenings. The membrane edge is tucked inside a metal perimeter flashing.
Standing seam roofing	Composed of preformed or field formed pans, usually 45 to 60 cm wide. These pans run parallel to the roof and are joined to adjacent pans with double-locked standing seams. The seams have cleats 30 cm apart which locks the panels on the deck. Metal (e.g., copper) roofing may exhibit this type of construction.
Tilt-up concrete panel	A prefabricated concrete wall panel, often containing openings for windows and doors, that is hoisted into place by a crane or other mechanism. The roof diaphragm acts as a connector between the panels. However, the panels typically are not connected to each other to allow for expansion and contraction.
UB	Upper Bound value for 3-second gust wind speed at 10 m in flat, uniform, open terrain

EF-SCALE (CANADA)

EF-Scale Rating	EF-Scale Wind Speed Rounded to 5 km/h
0	90 – 130
1	135 – 175
2	180 – 220
3	225 – 265
4	270 – 310
5	315 or more

ACKNOWLEDGMENTS

Damage indicator information for DI 1-26 from McDonald, J. and K. C. Mehta, 2006: A Recommendation for an Enhanced Fujita Scale (EF-Scale), Revision 2. Wind Science and Engineering Research Center, Texas Tech University, Lubbock, TX, 111 pp.

Damage indicator information for DI C-3 (C-HC) was adapted from a 'Churches' Damage Indicator developed by Keraunos for France (provided by Dr. Emmanuel Wesolek, see <http://www.essl.org/ECSS/2011/programme/presentations/111.pdf>)

Most glossary information from NOAA's Warning Decision Training Branch (see <http://www.wdtb.noaa.gov/>)