


REVIEW OF TORNADO PARAMETERS FOR TEMELIN NPP

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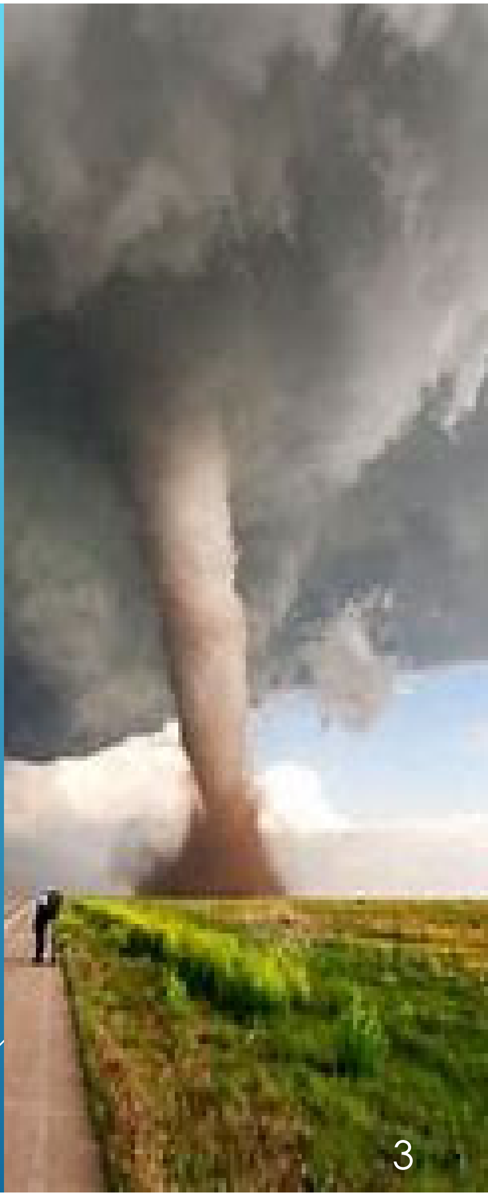
Analysis Commissioned by CEZ/Jacobs

BACKGROUND

- ČHMÚ prepared tornado hazard assessment for Temelín site applying IAEA SG-511A, IAEA NS-G-3.4, and IAEA SSG-18
  - Determined occurrence frequency for each F-scale intensity
  - Developed methodologies to establish important DBT parameters
- DBT parameters included translational speed, rotational speed, maximum speed, radius of maximum speed, pressure drop, rate of pressure drop, and duration of wind intensity above specified level
- ČHMÚ assessment based on limited tornado climatology data base
  - 27 tornado events from 1910-2018 with some inaccurate parameters
  - Classified according to older Fujita-Pearson (F) intensity scale
- ČHMÚ indicated calculated design basis parameters have a significant degree of aleatory and epistemic uncertainty, both in limited data base and methodologies
- Due to these uncertainties, an independent review was commissioned and undertaken

INDEPENDENT ASSESSMENT APPROACH

- Review ČHMÚ report and compare Czech & US approaches to determine pressure drop and rate of pressure drop for design basis tornado (DBT)
- Determine if ČHMÚ calculations are realistic based on US experience
- If NRC RG 1.76 is applicable to Temelin site, establish whether site is like RG 1.76 Region III
- Determine if US NPPs consider duration of wind intensity above specified levels in Design Basis Tornado design
- Describe how duration is established based on US data and, if applicable, establish for Temelin NPP



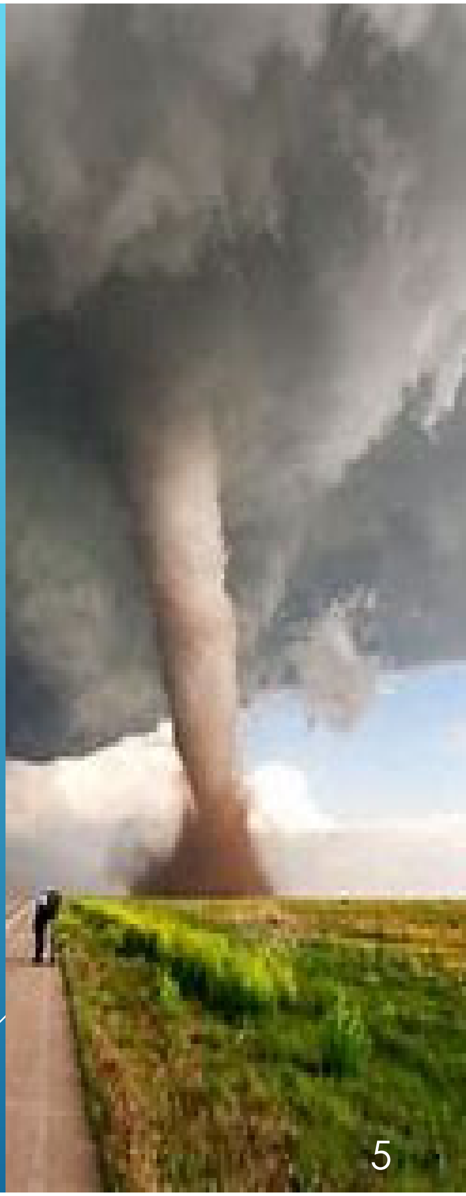
INDEPENDENT ASSESSMENT OF THE ČHMÚ TORNADO EVALUATION

Data Base Representativeness

DBT Parameter Calculation Methodology

REPRESENTATIVENESS OF TORNADO INVENTORY DATA BASE

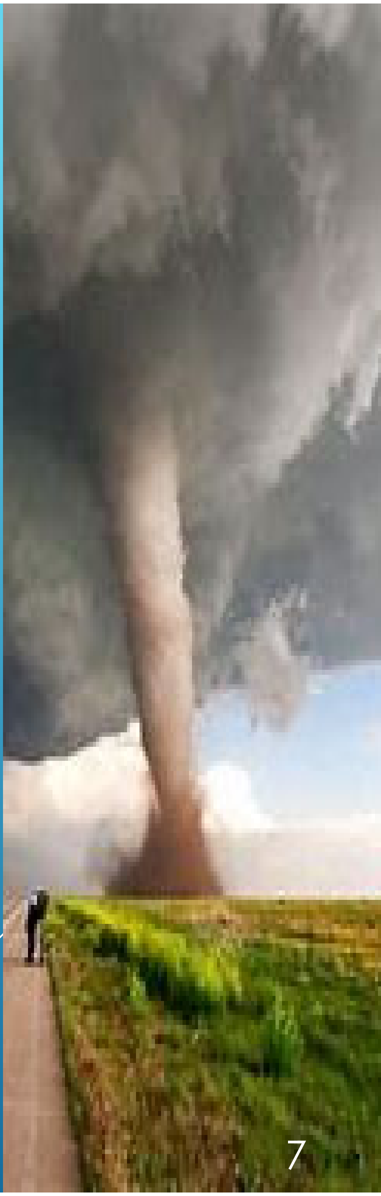
- Representativeness of ČHMÚ tornado inventory data base is important since all DBT parameters are dependent on establishing a reasonably accurate path length, path width, and F-scale intensity
- ČHMÚ report conceded that there may not be sufficient data to determine all required design basis parameters for input to applicable IAEA safety standards
- Data base consisted of DBT parameters from 27 tornado events from 1910-2018 for a 130-km radius region centered on Temelin site
- Šumava mountain region to SW excluded from data base
  - Tornadoes rare in mountainous terrain due to strong frictional forces of topography and morphology
  - Inclusion of this region would be non-representative



Date of occurrence	Occurrence site	Latitude (°N)	Longitude (°E)	I*	Path width (km)	Path length (km)	Path direction	Affected area (km²)	Estimate V_T (m/s)
20.5.1950	Čimice, Chabry (severně od Prahy)	50.14	14.44	F3				1.075*	
25.6.2008	Pohled - Smrkový Týnec (okr. Chrudim)	49.89	15.73	F2	0.15	5	W-E	0.750	3.5
31.5.2001	Vilémovice, Mrzkovice	49.68	15.34	F2	0.4	10	WNW-ESE	4.000	8
31.5.2001	Milošovice (okr. Kutná Hora) - Velká Paseka (okr. Havlíčkův Brod)	49.71	15.17	F2	0.45	4.5	WNW-ESE	2.025	7.5
31.5.2001	Kochánov/Střížkov	49.79	14.78	F2	0.2	3	WNW-ESE	0.600	7
2.7.200	Krasíkovice (okr. Pelhřimov)	49.46	15.23	F2	0.075	5		0.375	6
27.6.1997	Díly (okr. Rokycany)	49.77	13.62	F2	0.2	13		2.600	7
16.7.1993	Spálené Poříčí (jižně od Plzně)	49.61	13.60	F2	0.3	3		0.900	7
11.5.1910	České Budějovice - JZ Čechy	49.00	14.50	F2	0.065	150	SE-NW	9.750	13.1
7.8.2002	Litschau	48.93	14.98	F2	0.1	3	NW-SE	0,3	
11.2.1988	Naarn im Machland	48.22	14.60	F2		3		2.625*	
28.1.1994	Hargelsberg	48.15	14.42	F2				2.625*	
27.7.1995	Putzleinsdorf / Bez. Rohrbach	48.52	13.87	F2				2.625*	
19.8.1966	Litschau	48.95	15.05	F2	0.05	9	SE-NW	9.05	
6.9.1935	Wimm	48.23	14.62	F2	0.1	5	NW-SE	0.5	
23.9.2018	Lišany (okr. Rakovník)	50.14	13.72	EF1	0.1	9	W-E-SE	0.900	15
23.9.2018	Horšov (okr. Domažlice)	49.54	12.92	EF1	0.05	3		0.150	10
28.9.2007	Deštná u Jindřichova Hradce	49.26	14.92	F1	0.3	0.5	SW-NE	0.150	4.2
19.7.2007	Zbytiny (okr. Prachatice)	48,94	13.98	F1	0.075	0.8	S-N	0.060	7
12.7.2006	Vodňany - Křtětice	49.16	14.16	F1	0.1	0.5	NE-SW	0.100	5
7.8.2002	Mýtinky u Nové Bystřice	49,00	15.16	F1	0.01	1.5	NE-SW	0.015	12.5
13.7.2002	Sázava (okr. Kutná Hora)	49,88	14.91	F1	0.05	0.2		0.010	1
3.8.2001	Chlum u Třeboně (okr. Jindřichův Hradec)	48,95	14.95	F1	20	85	WSW-ENE	17+	5.2
31.5.2001	Dušníky nad Vltavou	50.30	14.34	F1	0.1	1	NW-SE	0.100	15
9.8.1987	Plzeňsko	49.10	13.50	F1	0.2	4	SW-NE	0.800	20
13.7.1998	Bad Hall	48.03	14.22	F1				0.45*	
29.5.1977	Gutenbrunn - Martinsberg	48.37	15.13	F1				0.45*	

TORNADO DATA BASE WEAKNESSES

- Some tornado data base values are questionable
  - 3.8.2001 path width of 20 km & path length of 85 km: Much too large for F1 tornado, were correctly downwardly adjusted by 2 orders of magnitude. IAEA safety guides suggest a path length of 1.6-5.0 km and path width of 0.016-0.05 km for F1 tornado
  - 11.5.1910 tornado path length of 150 km: Much too long for F2 tornado which was not adjusted. IAEA safety guides suggest a path length of 5.1-16 km for F2 tornado
  - 20.5.1950 tornado classified as a F3 without any path length & path width, even though an affected area of 1.075 km^2 was estimated. Affected area too small for typical F3 tornado
- 1950 tornado is only F3 in data base. Consideration to eliminate it is merited due to unknown information associated with width and length
- Intensity of 25 of 27 tornadoes classified by Fujita-Pearson tornado intensity scale (F scale), as shown in Table A10 of IAEA 50-SG-S11A. Two 2018 tornadoes were classified by Enhanced Fujita (EF) scale, adopted for international use in 2007

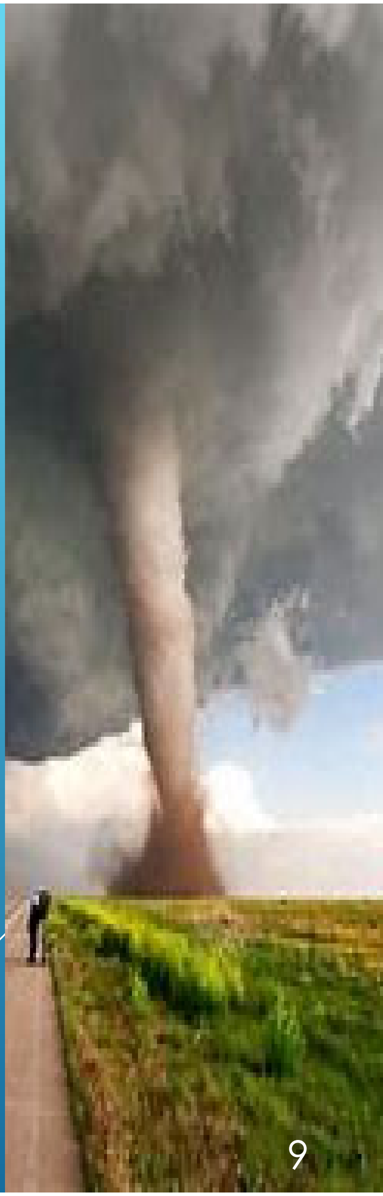


Comparison of Fujita Scale and Enhanced Fujita Scale Tornado Intensities

Intensity	Damage Description	Original Fujita Scale (Fastest quarter mile, mph)	Fujita Scale (3-s gust, mph)	Operational Enhanced Fujita Scale (3-s gust, mph)
F0	Light damage	40 to 72	45 to 78	65 to 85
F1	Moderate damage	73 to 112	79 to 117	86 to 110
F2	Considerable damage	113 to 157	118 to 161	111 to 135
F3	Severe damage	158 to 206	162 to 209	136 to 165
F4	Devastating damage	207 to 260	210 to 261	166 to 200
F5	Incredible damage	261 to 318	262 to 317	>200

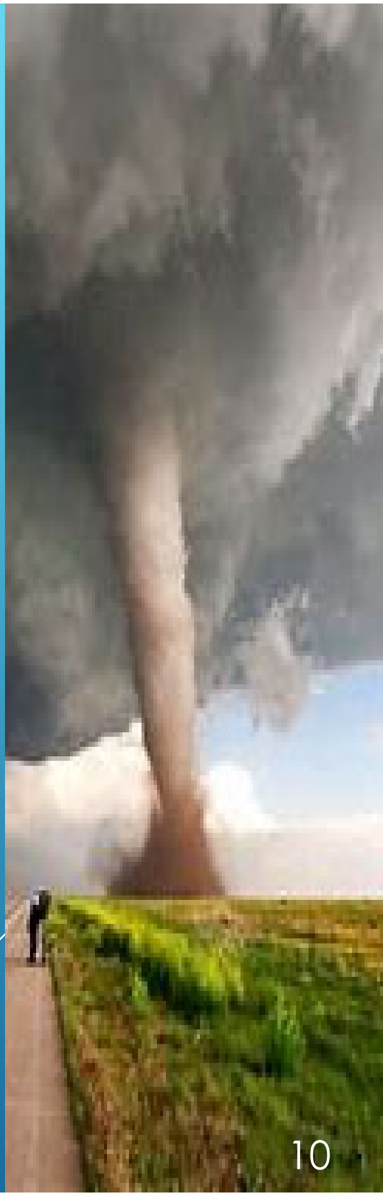
TORNADO DATA BASE ANALYSIS

- From 27 tornado sample, all but 1 had F1 & F2 intensities, no F0 tornadoes
  - Majority of F2 tornadoes are in lower half of F2 scale
  - F1 tornado path length ranged from 0.2-4 km & path width from 0.01-0.3 km
  - F2 tornado path length ranged from 3-13 km & path width from 0.05-0.45 km
  - Path lengths & widths consistent with F1 & F2 ranges for US tornadoes in IAEA safety guides and NUREG/CR-4461
- For 109-year period, there were no F0 tornadoes, 1 questionable F3 tornado, 14 F2 tornadoes, and 12 F1 tornadoes in a large region of approximately 45,000 km^2
  - Same tornado was documented that touched down in several locations
  - Only 23 tornado events documented over 109-year period
- Corroborated that tornadoes in this region are rare, as expected climatologically



TORNADO DATA BASE ANALYSIS CONCLUSIONS

- Data base judged to be reasonably representative and adequate for determining DBT parameters
  - Improvements could be pursued to better populate unknown width and length parameters
  - Provide technical justification for downgrading 1950 F3 tornado classification
  - Possibly look to increase sample size by expanding tornado occurrence region
- Tornado frequency & intensity of tornadoes near Temelin appears to be analogous to a Region III US location per criteria in NRC RG 1.76 and its technical support document NUREG/CR-4461



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ČHMÚ TORNADO EVALUATION

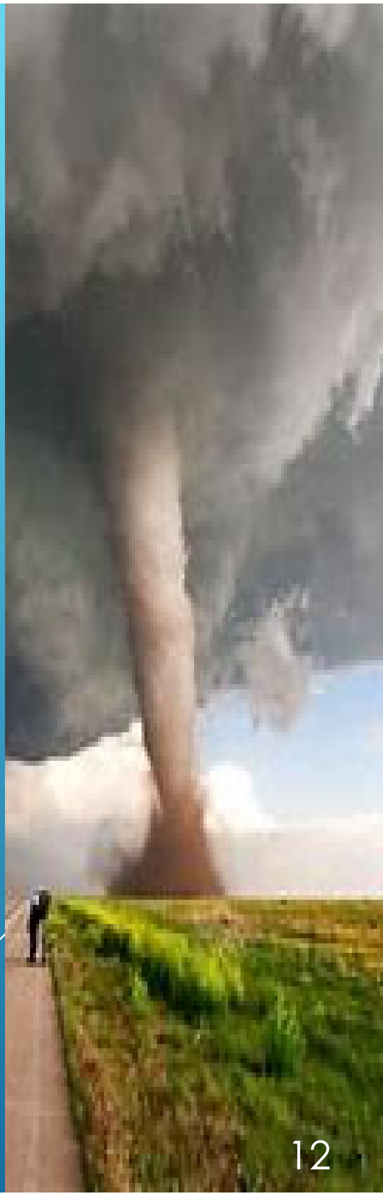
Data Base Representativeness

DBT Parameter Calculation Methodology

ČHMÚ TORNADO OCCURRENCE PROBABILITY

- ČHMÚ applied Equation A43 of IAEA 50-SG-S11A to calculate annual point tornado strike occurrence and return period for F1, F2 and F3 tornadoes
- Occurrence frequency is inversely proportional to return period

F Scale	Occurrence Frequency (yr^{-1})	Return Period (yr)
F1	2.4 E-5	42,000
F2	2.0 E-5	50,000
F3	2.0 E-8	50,000,000



ČHMÚ TORNADO TRANSLATIONAL AND ROTATIONAL WIND SPEED CALCULATION

F scale	Estimate	V (m/s)	V_T (m/s)	V_m (m/s)	R_{Vm} (m)
F2	average	43	8.7	35	50
	maximum	67	13.1	54	
F1	average	38	7.4	31	50
	maximum	77	15.0	62	

- V = Maximum speed (m/s)
- v_T = Translational speed (m/s)
- v_m = Maximum rotational speed (m/s)
- R_{Vm} = Radius of maximum rotational speed (m)
- $V = v_T + v_m$

- Tornado destructive force proportional to wind speed caused by rotational speed of storm
- To calculate damage potential of a tornado, input translational speed, rotational speed, and radius of maximum rotational speed
- IAEA NS-G-3.4 methodology calculates DBT parameters from intensities, path width and path length of 27 data base tornadoes
- IAEA 50-SG-511A methodology determined empirical value of 50 m for radius of maximum rotational speed and for other required DBT parameters, close to values used by NRC
- Translational speed for F1 and F2 tornadoes estimated from damage descriptions, path length, path width, and duration time, leading to calculation of maximum rotational speed

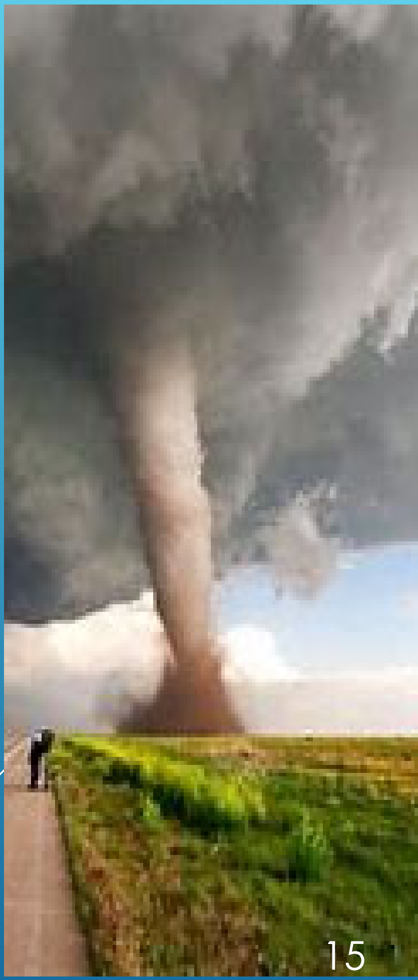
ČHMÚ TORNADO PRESSURE DROP AND RATE OF PRESSURE DROP

F scale	Estimate V_T	v (m/s)	v_T (m/s)	v_m (m/s)	R_{Vm} (m)	Δp (hPa)	$v_{\Delta p}$ (hPa/s)
F2	average	43	8.7	35	50	15.7	3
	maximum	67	13.1	54		38.2	10
F1	average	38	7.4	31	50	12.2	2
	maximum	77	15.0	62		50.1	15

- Pressure drop & rate of pressure drop based on IAEA 50-SG-S11A Equation A45
- Δp = pressure drop (hPa)
- $v_{\Delta p}$ = rate of pressure drop (hPa/s)

ČHMÚ TORNADO GENERATED MISSILES

- Sparse information on tornado missiles in Czech Republic literature to create data base
- Anecdotal information from 27.6.1997 tornado hurling 5-kg hammer 30-m distance, & damage to roofs & tree branches, suggesting tornado-missile activity
- IAEA guidance on tornado missiles insufficient
- ČHMÚ correctly assessed calculated DBT parameters are comparable to those of US Region III tornado, and generated missiles for the following three RG 1.76 Region III cases:
  - (1) 168-mm diameter steel pipe 4.58 m long, weighing 130 kg, impact speed of 24 m/s
  - (2) 1,178-kg automobile, impact speed 24 m/s, impact height up to 9.14 m
  - (3) 2.54-cm radius steel sphere, impact speed of 6 m/s



ČHMÚ TORNADO PATH DIMENSIONS AND TRAJECTORIES

- Czech tornadoes usually move from SW-NW towards with very few cases of E-W moving tornadoes
  - Frequent SW-NW trajectories may be due to climatological factors of instability caused by the overrunning of warm moist air from the south over an incoming cold front from the north, triggering severe thunderstorms with embedded tornadoes

ČHMÚ DURATION OF WIND INTENSITY ABOVE SPECIFIED LEVELS

- Literature search to determine duration of tornado event as a function of its intensity
  - 2007 technical paper: Typical tornado lifetime on order of minutes to ten minutes
  - 2014 American study: Duration ranged from 5-14 minutes but no relationship between duration and tornado intensity
  - Another 2014 American study: Developed relationship between tornado intensity and path length
  - 1996 American study: Dependency of tornado intensity on its translational speed. Concluded tornado intensity increases with translational speed of storm
- No study provided sufficient information to establish tornado duration as a function tornado intensity or define tornado duration parameter

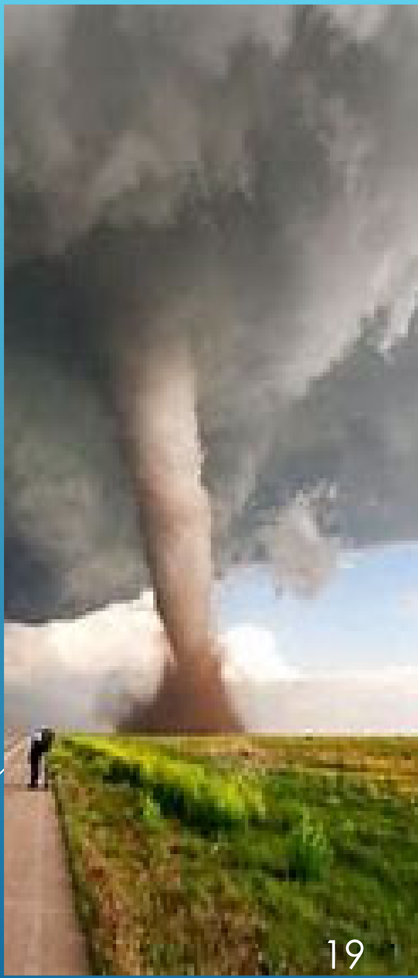
INDEPENDENT ASSESSMENT OF THE ČHMÚ TORNADO EVALUATION

Data Base Representativeness

DBT Parameter Calculation Methodology

INDEPENDENT ASSESSMENT USING US METHODOLOGIES

- US documents referenced to establish DBT parameters:
    - USNRC RG 1.76, "Design Basis Tornado and Tornado Missiles for Nuclear Power Plants", Revision 1, March 2007
    - NUREG/CR-4461, "Tornado Climatology for the Contiguous United States", Revision 2, February 2007
    - ANSI/ANS-2.3-2011 (R2016), "Estimating Tornado, Hurricane, and Extreme Straight-Line Wind Characteristics at Nuclear Facility Sites", 2016
    - ASCE 7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures", 2016
    - DOE-STD-1020-2016, "Natural Phenomena Hazards and Design Criteria for DOE Facilities, 2016
    - DOE-HDBK-1220-2017, "Natural Phenomena Hazards and Design Handbook for DOE Facilities, 2017



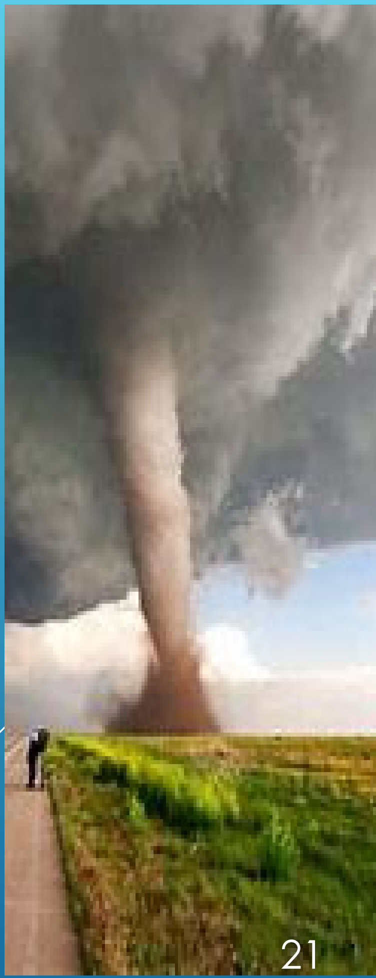
INDEPENDENT ASSESSMENT: APPLICABLE US TORNADO REGION

- ČHMÚ 27-tornado inventory data set reasonably representative
- Tornado intensity, path length and path width data from that inventory used to calculate
  - Frequency of point tornado strike
  - DBT parameters
- Results suggest that Temelin tornado climatology is like RG 1.76 US Region 3 (Western US) tornado climatology
  - Tornadoes are rare in Temelin region as they are west of the US Rocky Mountains

INDEPENDENT ASSESSMENT: TORNADO PATH LENGTHS AND PATH WIDTHS

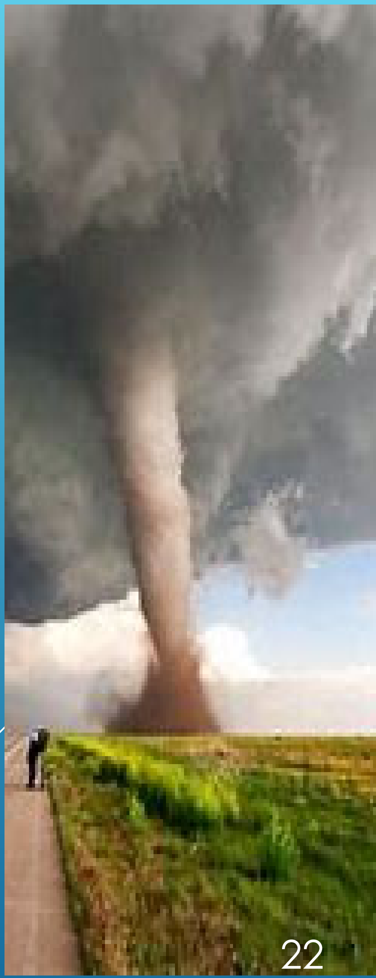
	F0	F1	F2	F3	F4	F5
# of Segments with Path Length	2451	1254	402	76	20	0
Median (mi)	0.293	0.901	2.243	2.902	13.721	0
Average (mi)	1.050	2.383	5.669	6.016	21.555	0
# of Segments with Path Width	2969	1615	524	99	21	3
Median (ft)	75.6	121.2	183.2	255.0	1189.9	134.6
Average (ft)	113.9	192.9	339.3	553.7	2045.0	149.0
# of Segments with Affected Area	2438	1251	402	76	20	0
Median (mi^2)	0.004	0.0218	0.0918	0.1833	3.5015	0
Average (mi^2)	0.046	0.1254	0.5464	0.9515	9.3826	0

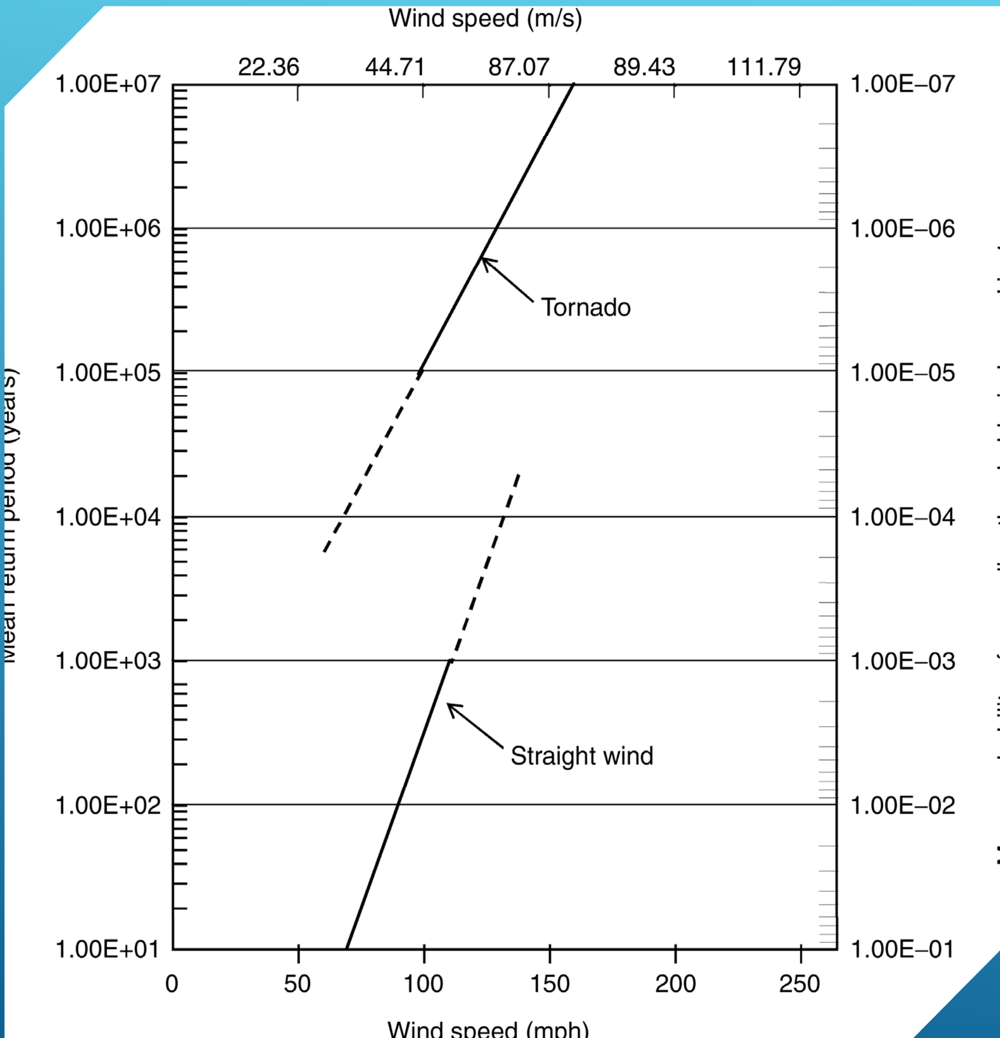
- ČHMÚ F1 and F2 tornado path length and path width statistics were compared to path length and path width statistics for F1 and F2 tornadoes in Table 2-6 of NUREG/CR-4461, "Tornado Segment Statistics for the Western United States"
- Relevant portions of this table shows median and average path lengths, path widths and affected areas for each of the 6 F scale intensities



INDEPENDENT ASSESSMENT OF TORNADO PATH LENGTHS AND PATH WIDTHS

- It was determined that intensity size distribution of ČHMÚ tornado data base looks like Region III (Western US) for both F1 & F2 intensities
- US Region III has some F3 and greater tornadoes, while limited CHMU data set has only one questionable F3 tornado
- It was concluded that Temelin is representative of US Region III with respect to tornado path widths & path lengths
- Tornado climatology at Temelin is even more benign than US Region III





INDEPENDENT EVALUATION OF TORNADO OCCURRENCE PROBABILITY

To establish that Temelin is representative of US Region III with respect to point tornado strike probability, probabilities for F1 & F2 intensity tornadoes were compared to

- ANSI/ANS-2.3-2011(R2016)
- NUREG/CR-4461 Revision 2

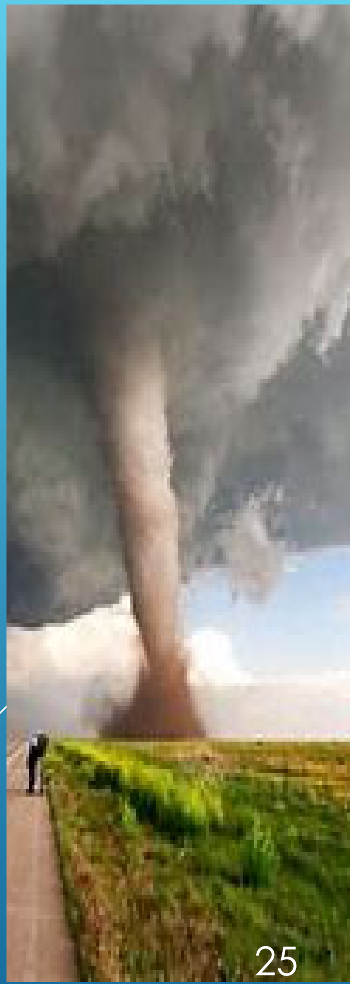
INDEPENDENT EVALUATION OF TORNADO OCCURRENCE PROBABILITY

- For a 100-mph tornado wind speed, mean value of probability for a tornado point strike on a structure is 1.00 E-5/yr.
  - NUREG/CR-4461 Table 5-1 shows an expected value of 1.67 E-5/yr for a Western United States location
- NUREG/CR-4461 Table 8-1, Recommended Tornado Design Wind Speeds shows that a 100-mph tornado wind speed for a Region III site has a design probability of 1.0 E-5/yr, in line with Temelin calculations
- Consistent with calculated 1.96-2.4 E-5/yr point strike probabilities presented in Table 1 of the ČHMÚ Temelin report, which shows average tornado wind speeds ranging from 38-43 m/s

US REGION III DESIGN BASIS TORNADO PARAMETERS

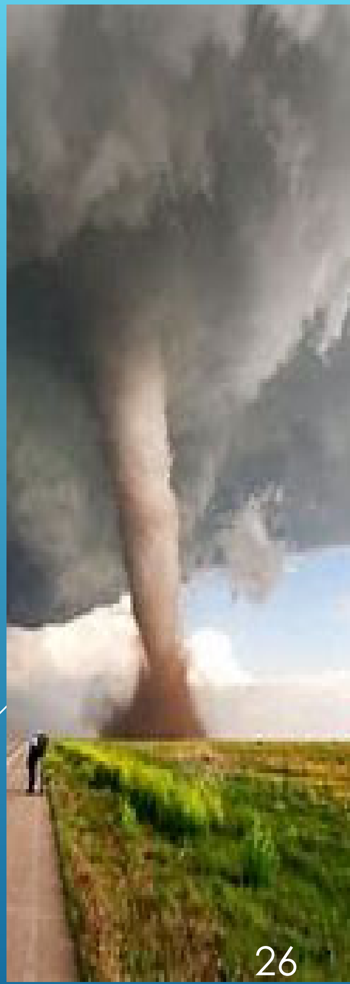
Region	Maximum wind speed m/s (mph)	Translational speed m/s (mph)	Maximum rotational speed m/s (mph)	Radius of maximum rotational speed m (ft)	Pressure drop mb (psi)	Rate of pressure drop mb/s (psi/s)
I	103 (230)	21 (46)	82 (184)	45.7 (150)	83 (1.2)	37 (0.5)
II	89 (200)	18 (40)	72 (160)	45.7 (150)	63 (0.9)	25 (0.4)
III	72 (160)	14 (32)	57 (128)	45.7 (150)	40 (0.6)	13 (0.2)

- RG 1.76 DBT wind speeds based on data from Revision 2 of NUREG/CR-4461
- Extensive tornado database in NUREG/CR-4461 includes information from more than 46,800 tornado segments occurring from 1950-2003
- RG 1.76 Table 1 presents DBT characteristics for US Regions I, II and III, inclusive of pressure drop and rate of pressure drop
- Region III highlighted since it is the appropriate region to base the Temelin DBT calculations on



US REGION III DBT PARAMETERS

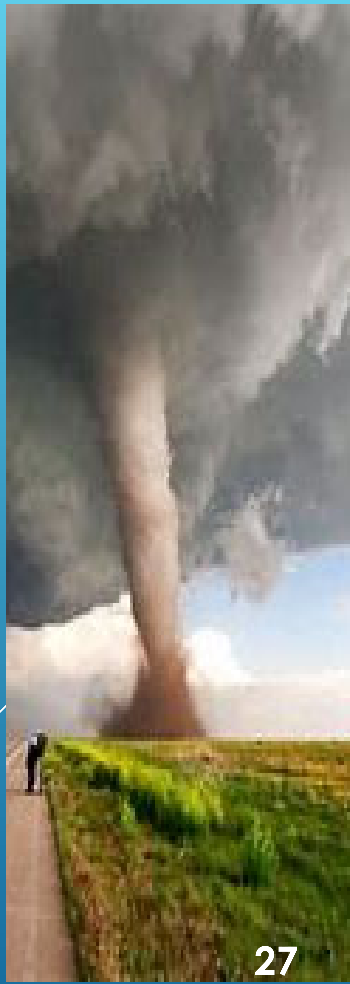
- For a Region III site, applicable DBT parameters are:
  - Maximum wind speed = 72 m/s
  - Translational wind speed = 14 m/s
  - Maximum rotational wind speed = 57 m/s
  - Radius of maximum rotational speed = 45.7 m
  - Pressure drop = 0.6 psi = 40.8 hPa
  - Rate of pressure drop = 0.2 psi/s = 13.6 hPa/s
- Comparing rate of pressure drop to total pressure drop suggests that pressure drop (APC) for a Region III tornado occurs over a 3-second period



US REGION III DESIGN BASIS TORNADO PARAMETERS

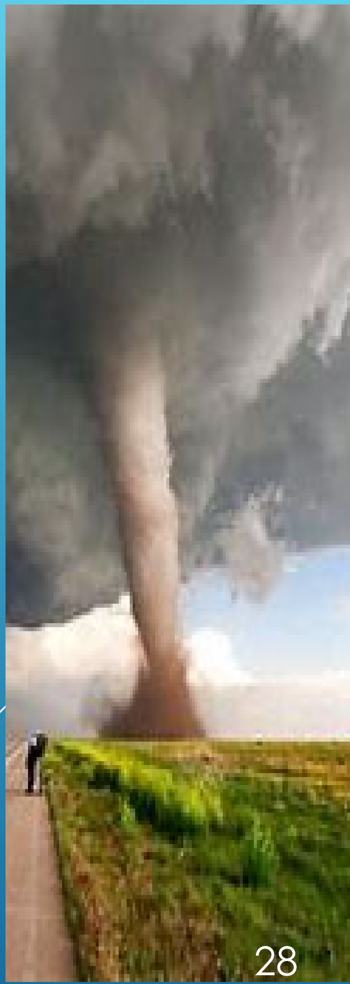
Maximum tornado wind speed (V)	Translational wind speed (T)	Radius (R_m)	Maximum atmospheric pressure drop (Δp)
250 mph (112 ms^{-1})	55 mph (24 ms^{-1})	435 ft (133 m)	1.35 psi (9.1 kPa)
200 mph (89 ms^{-1})	45 mph (20 ms^{-1})	355 ft (108 m)	0.85 psi (5.8 kPa)
180 mph (80 ms^{-1})	40 mph (18 ms^{-1})	320 ft (98 m)	0.70 psi (4.8 kPa)
150 mph (67 ms^{-1})	33 mph (16 ms^{-1})	270 ft (82 m)	0.49 psi (3.3 kPa)
140 mph (63 ms^{-1})	32 mph (14 ms^{-1})	253 ft (77 m)	0.41 psi (2.8 kPa)
100 mph (45 ms^{-1})	25 mph (11 ms^{-1})	185 ft (56 m)	0.20 psi (1.4 kPa)
1 psi = 68 hPa			

- In addition to NRC RG 1.76, ANSI/ANS-2.3-2011(R2016), provides additional guidance on design basis tornado characteristics
- National standard adopted by DOE in its NPH design standard DOE-STD-1020-2016
- Table 2 of ANSI/ANS-2.3-2011(R2016) addresses translational wind speed, rotation radius, and maximum atmospheric pressure drop for 5 maximum tornado wind speed categories
- This table presents ANSI/ANS extreme wind standard values for various tornado wind speeds



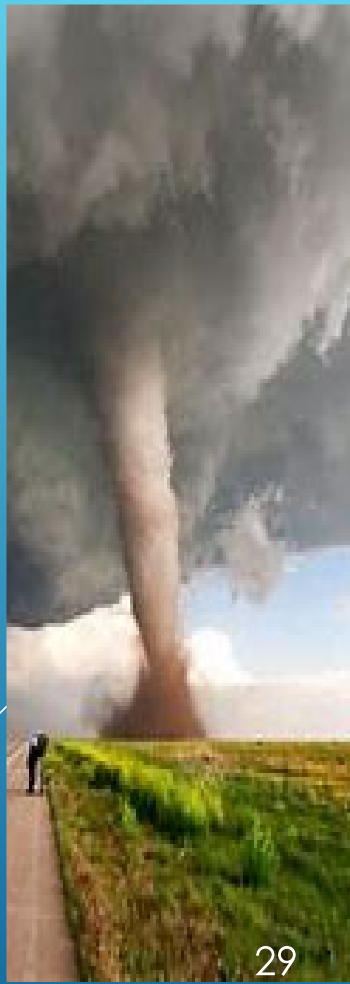
COMPARISON OF US REGION III DESIGN BASIS TORNADO PARAMETERS TO ČHMÚ

- RG 1.76 & ANSI/ANS-2.3-2011(R2016) gives ranges of DBT parameters for a Region III location:
  - Maximum wind speed = 72 m/s
  - Translational wind speed = 14-16 m/s
  - Maximum rotational wind speed = 57 m/s
  - Radius of maximum rotational speed = 45.7-56 m
  - Pressure drop = 0.6 psi = 40.8 hPa
  - Rate of pressure drop = 0.2 psi/s = 13.6 hPa/s
- Range of values in ČHMÚ Temelin report for F1 and F2 intensities are:
  - Maximum wind speed = 67-77 m/s
  - Translational wind speed = 13.1-15 m/s
  - Maximum rotational wind speed = 54-62 m/s
  - Radius of maximum rotational speed = 50 m
  - Pressure drop = 38.2-50.1 hPa
  - Rate of pressure drop = 10-15 hPa/s
- Accordingly, range of DBT parameters developed by ČHMÚ for Temelin are quite comparable
- Temelin site equivalent to NRC RG 1.76 Region III site and can adopt RG 1.76 DBT parameters



TORNADO PRESSURE DROP AND RATE OF PRESSURE DROP

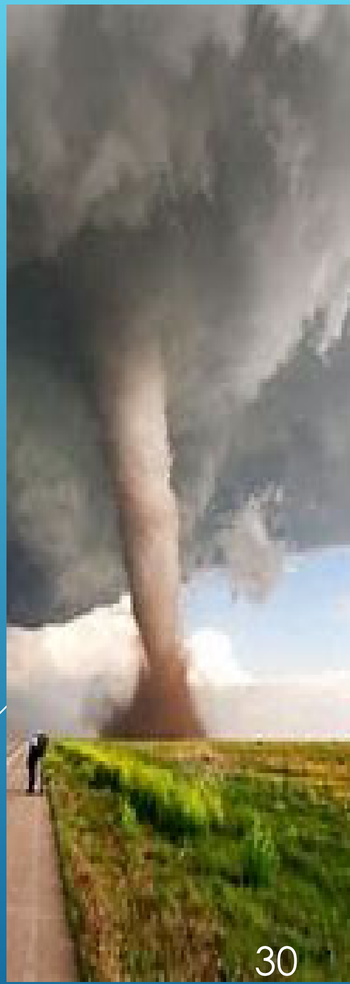
- With respect to pressure drop (APC), DOE-STD-1020-2016 provides the following guidance in Sections 4.4.2.5 and 4.4.2.6:
  - *4.4.2.5 When a structure is sealed, then the APC associated with a tornado, as shown in Table 2 of ANSI/ANS-2.3-2011(R2016), shall be considered instead of internal pressures*
  - *4.4.2.6 At the radius of maximum wind speed, the APC may be one-half its maximum value. For this reason, a critical tornado load combination for a sealed building shall be one-half the maximum APC pressure combined with the maximum tornado wind pressure, or one-half wind pressure, whichever controls design*



TORNADO-GENERATED MISSILE DESIGN CRITERIA

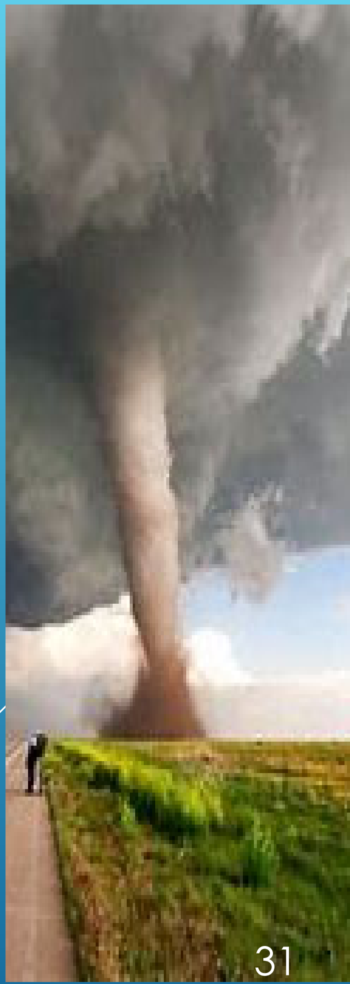
Missile	Horizontal wind speed range greater than V or V_h	Tornado (V) coefficient, k_1	Hurricane (V_h) coefficient, k_1
	Weight 4000 lb (1810 kg)		
Impact type: automobile, 20.0-ft^2 (2.0-mi^2) contact area	250 mph (400 kmph)	0.4	0.7
	200 mph (325 kmph)	0.4	0.7
	150 mph (245 kmph)	0.3	0.6
	100 mph (160 kmph)	0.3	0.5
	Weight 287 lb (130 kg)		
Penetrating-type, Schedule 40 pipe, 6.0-in. (150-mm) diameter, 15-ft. (4.58-m) length	250 mph (400 kmph)	0.4	0.5
	200 mph (325 kmph)	0.4	0.5
	150 mph (245 kmph)	0.4	0.5
	100 mph (160 kmph)	0.4	0.5
	Weight 0.147 lb (0.0669 kg)		
Solid steel sphere, structural opening 1.0-in. (25-mm)-diameter	250 mph (400 kmph)	0.1	0.5
	200 mph (325 kmph)	0.1	0.4
	150 mph (245 kmph)	0.1	0.4
	100 mph (160 kmph)	0.0	0.3

- Table 4 of ANSI/ANS-2.3-2011(R2016), standard design missile spectrum for tornado- and hurricane-type winds provides guidance to establish horizontal speed coefficient of tornado-generated missiles



DURATION OF WIND INTENSITY ABOVE SPECIFIED LEVELS

- With respect to duration of a tornado, generally weak tornadoes (EF0/EF1) last for about 10 minutes & stronger tornadoes (EF2/EF3) last for about 20 minutes
- There is much variability in duration from storm to storm
- Detailed studies of tornado damage would be needed to sharpen duration parameter which may not have merit since it is not required as US does not use tornado duration in its DBT calculations
- It can be implied that if SSCs are appropriately designed to withstand a DBT, it can do so for a reasonable time duration of a tornado strike, which is likely on the order of minutes



CONCLUSIONS AND RECOMMENDATIONS

Independent evaluation firmly establishes Temelin is representative of NRC RG 1.76 Region III location and Region III parameters can be used for Temelin DBT calculations

No additional insights into tornado duration of wind intensity above a specified level were located, but NRC RG 1.76 does not require this parameter

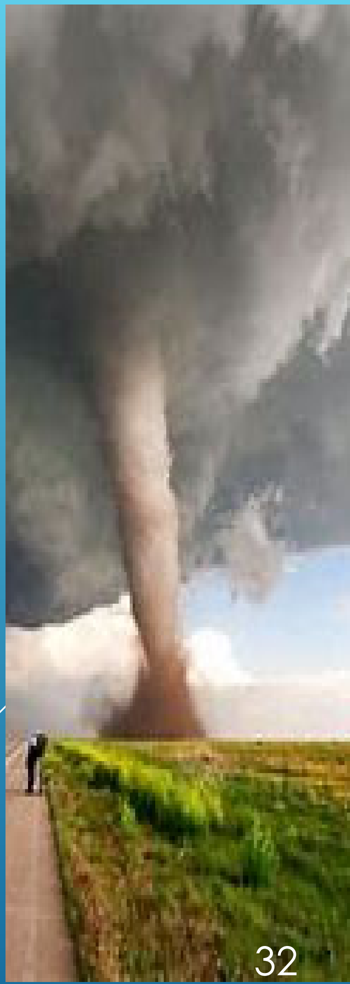
ČHMÚ tornado inventory is somewhat limited and small size may be reflecting small frequency of tornadoes that occur in the 130-km radius region centered on Temelin. It is recommended that tornado inventory be augmented by increasing radius of region

ČHMÚ tornado inventory has outlier values and needed some assumptions to supply sufficient path length & path width information, as well as to correct spurious values.

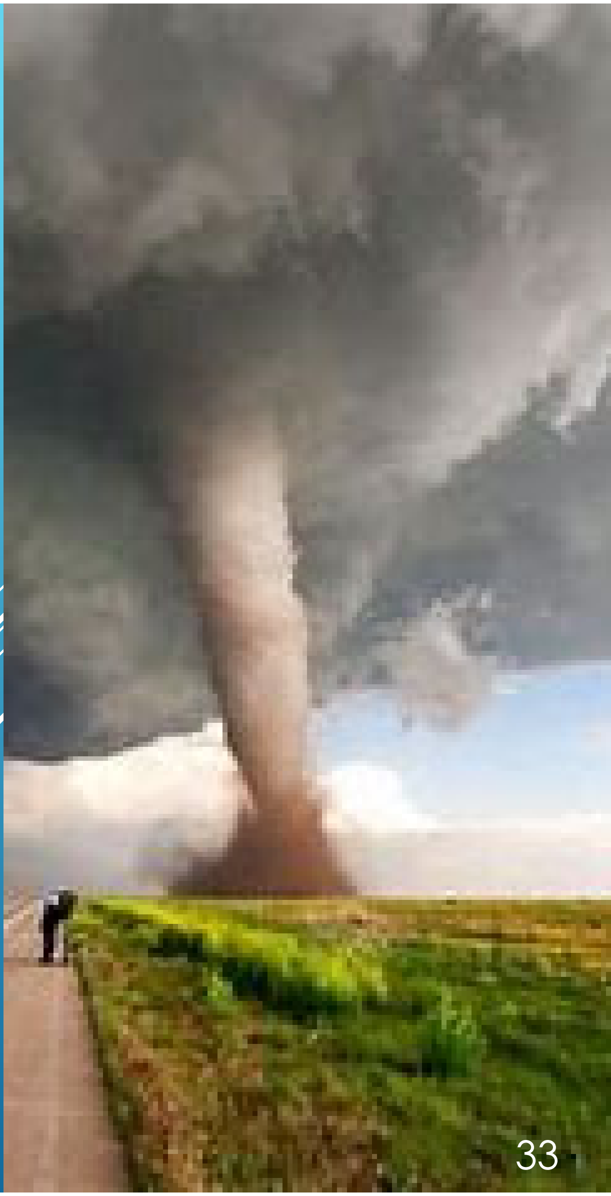
ČHMÚ calculated tornado wind parameters and point tornado strike frequency values appear reasonable. It is recommended that the F3 tornado be reevaluated, and a spurious path length be corrected

Occurrence frequency for F3 tornado of 2.0 E-8 is based on one questionable tornado intensity. It is recommended that F3 tornado occurrence frequency reevaluated

IAEA methodologies appear to be consistent with methodologies used to develop RG 1.76



QUESTIONS?



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