REGIONE BASILICATA



COMUNE DI ALIANO (MT)



PROGETTO DEFINITIVO RELATIVO ALLA REALIZZAZIONE DI UN IMPIANTO EOLICO COSTITUITO DA 6 AEROGENERATORI E DALLE RELATIVE OPERE DI CONNESSIONE ALLA R.T.N.

RELAZIONE ANEMOLOGICA

ELABORATO

A.5

INGEGNERE Alessandro

Antezza Sez. A - 10743

PROPONENTE:



SKI 04 s.r.l.

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CONSULENZA:

PROGETTO E SIA:



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Via Caduti di Nassiryia, 55 70124- Bari (BA) pec: atechsrl@legalmail.it

Ing. Alessandro Antezza

II DIRETTORE TECNICO Ing. Orazio Tricarico





SOLARITES s.r.l.

piazza V.Emanuele II n.14 Ceva (CN) 12073

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2 J J H W W R G H O S U H V H Q W H V W X G L R U H D CO LLA J D W R 6G LD CO THO D R J D I F D U D W W H U L J D J L R Q H D Q H P R O R J L F D G D J L X R Q M L C W R S H L C W D W M H Q C F R D W W H V D G L X Q L P S L D Q W R H R O L F R H VI L W W R L L Q L R R F B D X C W D O M H C L L S D L L S D L L S D W L V T W Q M M P R P Y H R N O U V L D L D W D L S H D U L R R D W L V T W Q M P R P Y H R N O U V L D L D W D L S L G D U F L R C D W D L S L S D U W R Q W L S H,) Y H W I I I L D I D L S D U W H Q H Q W L D O O D S L O D P S L D D U H D F R Q V L G H U D W D

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5HO 7*

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3 HU OH YDOXWD]LRQL GL SURGXFLEVLVOIDWIJL OXHVOLOVIHJJI WWW RL GGHDWFIU DQHPRPHWULFD WXWW¶RJJL DWWLYD QOBHOODRIPKLQDDVOD ISLLQHUOLIPHXODWRHULFRHUHQ]D GHOOD VHULH GL GDWL LRLSRLUHUDDFWBOQ QUVRVQDWWRR WYURDO VGRHWWVHULH DQHPRPHWULFKH G¶DUHD D TXHVWWLD SOURXXVIILUPDHIDUFFRQODEXERQUUDSSUHVHQWDWLYLWJ GHOOD ULVRUWDUIGFDDSVDFUHVOHWDB HSOHOUDLVOWNDLJWRRQGH

, SURFHVVL GL DQDOLVL GHL GDWLUDLORHIRDRWFRHWUGELYGDDVLSGRDQLLREGOVX FFHVVLYD HODERUD]LRQH USLIPHUQWLRO VSR 190 RULDRP SGLRDP16GQLWQH\$COCONTHJDWFRXL\$ ELVRJQD ULIHULUVL SHU DSS MIR PRHOQOWLHP HDOOWOLH HVLYPHXUOLDDPR GHOOR QVWDWD LQYHFH XWLOLLIJEDLWODL OOTIL QRWOHWUDH VHUDLQHQIGL, QIDDWWLWHVVHUH GHILQLWD VWRULFD HG LO VDXORL 180 IRODROUFHK IPHS9HUR LDOQQX ROJRRL 180 MI

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3 HU LO VLWR LQ RJJHWWR VRQR VW DDVH HIRLJSHROWH LUJOPDWRHU LV 165 LL SIBIDI 12 SXQWL DYHQWL XQD EXRQD HVSRVL]LRLQQHDVSWUL RIVWHDFORROOL VDLOUILOVXFVR/OR

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- x \$ 5DFFROWD GHOOD GRFXPHQWDJLRQH WFHDFQLFD GHOOD VWD
- X \$ 7DEHOOH GHOOH GLVSRQLELOLW; HPRP@DOULHUD H PHQVLC
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/D PLVXUD D P GDO VXROR SUHVH®IWLDOXQDSCHLUVSL®OQSLEEUOR ®VR GEIPHVL LQ DFFRUGR DOOH QRUPDWLYHR UHHJVLRVQHDOOH, F ORDCWVLLQOR HQFRQVHJXHQ]D VL q GHFLVR GL XWLOUL] ODHUHY DOOT X WQ VV JHLUR DQLV HY VX EFFH OY V LOY ULSRUWDQR OH WDEHOOH FRPSOHWH GHOOH VWDWLVWLFKH SULQFLS



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3 HU FRQIHULUH VXIILFLHQWH VWDELSDRLWUJHD CG LF XX QFR XX CB H CP CORH FW WULGLPHQVLRQDOH FRQ VXSHUILFLH CS HL V WYD XX TDV DO D OT CX THLOP CS TD. DS OUWR IS UL I

, Q TXHVWR FDVR VL q XWLOL]]DWD XVQSDH PPIDISES DWGDLPHFQWMFHD XQ WHHD XQ WHHD XQ WHHD XQ WHHD Y PRQ FXUYH GL OLYHOOR GHURLGYHDOWOHRGGDL GLDWWDDDCHD VHQ YDDQ WWOD XO) > '(0@ GHOO LQWHUR WHUULWRULR LPWHDWOUD QRHUFRIOL FSDDWHVRFRGOL OF XORWDD GLQWRUQL GHO VLWR H GHOOH VWDN]LR3QHLUXWOLDO LPJDN WGHH VS H PDODD VDH UXJRVLW; GHO WHUUHQR GHULYDWD GDO GDWDEDVH & RULQH /DQG

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9HULILFD GHOO¶DSSURVVLPD|LRQH GHOOD FXUYD GL :HLEXOO

, O FRGLFH GL FDOFROR: \$ V 3 XWLOL\$ JHDU OUDD \$5 \$LV HAVUHLEE WY JDLURHO, HL GGID VG HILQLVFH LO FDPSR GL YHQWR LQIG IS VDW WD UP EHDWURL 16 HOU OL TYD WHLDG IS WYDDDOV

5,) B7 ± 'LVWULEX]LRQH GHOOD YHORFLW; GHOHYLHYQHYQRWL

3HU OD VWD]LRQH OD GLVWULEX]LRQRH **GL**: FIDEOX FOR FOR FOW LW DOULS RUWDWD QHOOD WDEHOOD VHJXHQWH GRYH

- N IDWWRUH GL IRUPD N GL WDOH GLVWULEX LRQH GL : HLEXOO
- 8 YDORUH PHGLR GHOOD YHORFLW; CRHUCH YGHLQCYLRUHLDL RPQVH SHU FLDVFX
- 3 SRWHQ]D VSHFLG: HFODO DQYHQD IOXLGD QHO VHWWRUH GL GLUH]LRQH
- I IUHTXHQID SHUFHQWXDOH GL RFFRGUSHQUHFQQIVO VHWWRUH SHU PLO

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'L VHJXLWR L SDUDPHWUL VSHWRLQPWRQFWRQFWRDQOTLXHYOEIQJYRA PRGHOOR FRPSUHQVLYL GHOOH LQIRVUSFDDJIDFOOHLGWHOUDUJIDWQRHUPIRDPOHLWUORHO SDUWHQGR GDO FDPSR GLYHQWR \$WODV

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/H GLVFUHSDQ]H ULVFRQWUDWH LQ TXQHIDVWGDHOYHPURLGHFODO FGHDQRRWYDUQ QHO SXQWR VSD]LDOH GHOO¶DQHPRPHFWHURTXWHODOL SBOODFWHLWWUDGQQNHHODFKH LQIOXLVFRQR PDJJLRUPHQWH VXOOHDUHVQWHLPDLYGFLRQWRUGDXWJHRQRHQFFRQWHQXWH HG DOO¶LQWHUQR GHOOHHH MOVFRHUWGHDJWHDWDSQLFKHH GOLDTXXVVD]LRQH H VRSUDWWXWWR O¶RUPFSJOUHDWND LQWHUFRUUHQWH SLXWW

6L SXz TXLQGL ULWHQHUH VRGGLVIDFHQWH OD YHULILFD SHU 5,

9HULILFD GHO JUDGLHQWH DO VXROR GHOOD YHORFLWj GHO YF

, O JUDGLHQWH DO VXROR GHOOD ҮННӨМХӨВМ, КӨНӨК QHOQW WH DOOLLDH V YHORFLW; GHO YHQWR DOOH YDULH DOOMW MYNJH QEIO 16 ЖКИОНКИРИ DO DYUHHU DSSURVVLPD]LRQL FKH LO PRGHOOR LUQDW PURGWXUFIN QUHLOVOSDH WWWLIR DDGLT UHJLVWUDWR VXOOD YHUWLFDOH GHOOD VWD]LRQH

1HO FDVR VSHFLILFR QRQ GLVSRQHQGRV&UDXWOR YSDHOURLOOHD GYLW
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QRUPDOPHQWH DWWHVL LQ UHOD]LRQQFRDQGODD OPDRUMWODRURD HGHDQQ HYEWRF
VSHFLILFR q OHFLWR DWWHQGHUVLQ XWQLWJUDFGRLQHQWYHYDDQORWXHRDORWORLD QR

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6HGH/HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

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5HO 7*

,PSLDQWR HROLFR LQ /RFDOLWj 3/H 6HUUH' QHO &RPXQH GL \$OLDQR 07 6WXGLR DQHPRORJLFR H SUHOLPLQDUH 9DORXONLBTLBOOMHW6HNDOD 3URGX]LRQH (

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1HO FDVR VSHFLILFR ROWUH D 5,)GDWLL GXWSLROQH DŒLL OD LOVSHUH VHU TXDOL ROWUH DG HVVHUH UDSSUMWHH JODWODLWRLYWX SIEIU VORRQRD DOQFJKOH LSFVUX SURJHWWR

\$ VHJXLWR GL XQD SULPD YHULILFD DQMHDOODHTXHDOORHFLVMR;QRHVGWLDIYPLVXUDWH D TXHOOH VWLPDWH GD :\$DVOHDQDDQDQDQRWWHWDRVCRHSDXQRMCRHOOBFRQVLGHUDWH OH ULVXOWDQ]H QRQ DVRVGVGDLJVLIRDOFHHQXWWLLOQLHJIDDWDLVYBROOQFDDFRODUH LO FDPSR GL YHQWR DSWMOVDWLYHGVWDQJDRVQLUHHGDDDWDLVYBLJ]DBSURYYHGXWR DG HVHJXLUH XQD VHFRQGD HODERUDJLRQH

6 L HYLGHQ]LD FKH VROLWDPHQWH JOLO HPURUGRHUOLO TR RVQVIR L P BI QOVDH QYXYYHQWR VXOOD VWD]LRQH VWHVVD FKH DOO¶RKHDQJVHHQ ISLU D WH BO H YP IBI VQ IV UTHX DXQYDOXWD OD YHQWRVLW J GHOO¶DOW UHD DVOVODD]LGRLQVHW DQ J BI VHD FDHO OL¶GR USRURL LQWHU FRUU HQWH

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9 D FRPXQTXH VRWWROLQHDWR FKH OODRGDLGILLFCRWOHWUJSGJIHIOW DPURIG HOODCGLYHUVL SXQWL GHO WHUULWRULR DVQHDDD IXJQDDWXRP HI QXWQRIDQWH WO QUHLQFKHL DL SDUDPHWUL GL YHQWRVLWJ FKH DVQRFHUDWHHJ] HDOLPFXGLH GIOIRI WGWLF SURGX]LRQH SHUZ WHQGRQR DG HVVHHUOHD WYLWRJGDHWOH SGUDHOVOHTQDWS EI UVRWF KDWR D YDOXWDUH OD UDJLRQHYROWR UVLRI VDWHRQQELOLW J GHO SURJHWV

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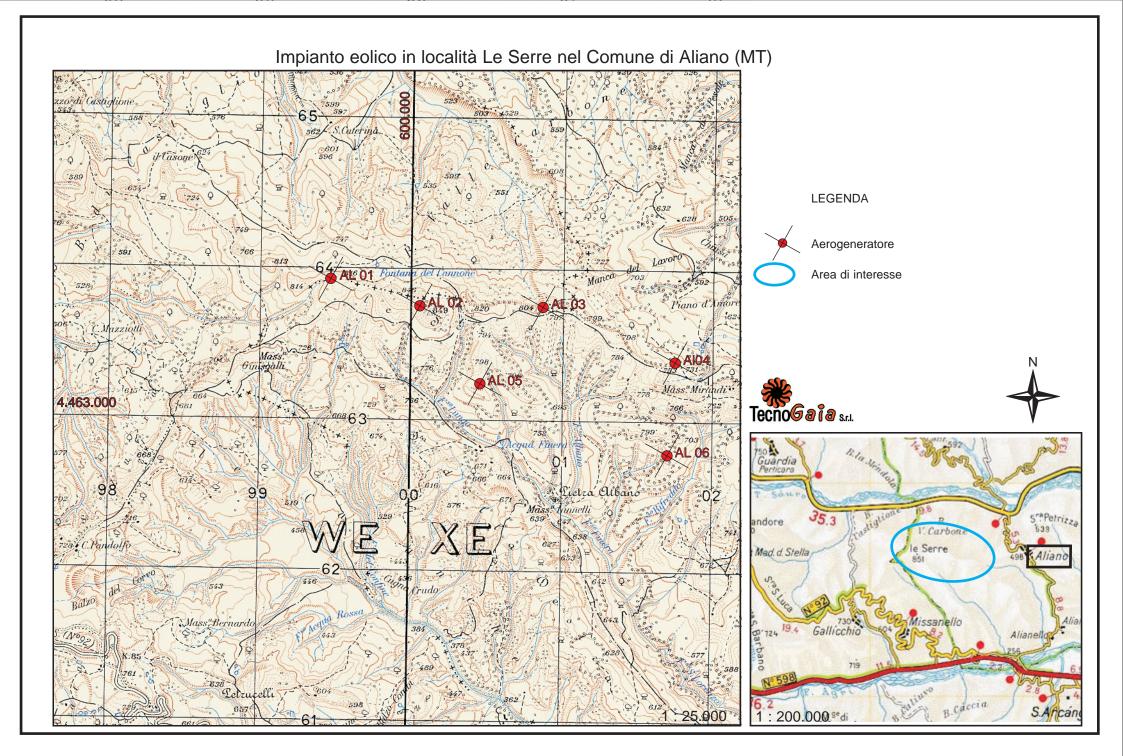
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Siemens Gamesa 5.X Reaching new heights





Siemens Gamesa technology with benchmark performance and proven reliability

SG 6.6-155 and SG 6.6-170: Siemens Gamesa next-generation solutions conceived to deliver an outstanding value proposition for our customers

Imagine how the future becomes present to take wind energy to the next level

At Siemens Gamesa, we strive to anticipate opportunities in an increasingly discerning market. Our wind technology expertise, backed by more than 40 years of experience and over 114 GW installed throughout the world, equips us with the right tools for imagining the future, making it present and taking wind energy to the next level.

We know what this means: technological leadership, solid track record, commitment to excellence, passion for what we do. And we deliver it now to our customers. This is how the new Siemens Gamesa 5.X onshore platform is born.

Siemens Gamesa 5.X is a new generation of

turbines that takes Siemens Gamesa to new heights:

- In performance, cost-ef ciency and reliability.
- In power output and rotor size to offer the most competitive LCoE.
- In technology, built upon Siemens Gamesa know-how and expertise.
- In versatility, with a modular, exible design that facilitates logistics, construction and service.
- In site adaptability, to con gure the optimal solution for each project.
- In value for our customers.



Proven technology

The new Siemens Gamesa 5.X onshore platform has its roots in Siemens Gamesa technology, synonymous with innovation, know-how and reliability accredited through experience. Siemens Gamesa 5.X incorporates proven technologies, minimizing risk and guaranteeing reliability for its two new product models: SG 6.6-155 and SG 6.6-170 wind turbines. These include a doubly-fed generator and partial converter combination, a compact drive train design with a three-stage gearbox, and the use of components widely validated on the other Siemens Gamesa platforms. The result is a wind turbine design that gives optimum performance and LCoE.

Benchmark in power output and rotor size

Siemens Gamesa 5.X goes one step further to become the new generation platform that combines a exible power rating from 5.6 MW to 6.6 MW with two of the largest rotor diameters in the market, 155 and 170 meters, resulting in maximum performance in high-, medium- and low-wind conditions.

SG 6.6-155 and SG 6.6-170 turbines mean greater AEP per wind turbine and optimized CAPEX for the project. This is also due to their versatility, with a modular, exible design for maximum ease of logistics, construction and O&M, as well as reducing the OPEX, which results in a lower Cost of Energy for projects.

Unique, tailored solutions

Siemens Gamesa 5.X considers pro tability to be a key factor in generating value for our customers. Contributing factors to pro tability include:

- Con guring exible, personalized power modes fully tailored to the needs of each site.
- An extensive catalog of towers with multiple available

- technologies and the additional capability to create speci c project designs.
- The use of advanced control strategies that enable intelligent load reduction and a greater applicability for the Siemens Gamesa 5.X platform in different wind conditions.
- A modular, optimized structure for local transport and construction conditions.
- A maintainability-oriented design with advanced diagnostics and remote operation solutions, as well as the possibility of replacing large turbine components without requiring a main crane.
- Optional product solutions to cover all types of market requirements.

Technical speci cations

	OptimaFlex /			
	SG 6.6-155	SG 6.6-170		
General details				
Rated power	6.6 MW			
Wind class	Medium and high	Low and medium		
Flexible power rating	From 5.6 MW to 6.6 MW			
Control	Pitch and variable speed			
Rotor				
Diameter	155 m	170 m		
Swept area	18,869 m²	22,697 m²		
Tower				
Height	90, 102.5, 122.5, 165 m and site-speci c	100, 115, 135, 165 m and site-speci c		
Technology				
Туре	Geared			
First prototype				
Date	2021			

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9\$/87\$ = ,21('(//(,1&(57(68(/\$ 0,685\$'(/ 9(172

&21&/86,21, '(//¶\$//(*\$72 \$

\$OOHJDWL

- (\$ 5DFFROWD GHOOD GRFXPHQWD]LRQH WHFHQWLUFDFGHOOD VWD]L
- x \$ 7DEHOOH GHOOH GLVSRQLELOLW; GDWL DQHPRPHWULFL
- x \$ 5LVXOWDWL GHOOH HODERUD]LRQL VWLFWULVWLFKH GHL GDWL

6HGH/HJDOH 9LD 0DWWHRWWEDUGREQH 9DO 7URPSLD %6

 $6\,W\,X\,G\,L\,R\,\,D\,Q\,H\,P\,R\,Q\!U\,R\!H.D\!L\,L\!F\!R\!R\!L\,Q\!I\,D\!S\!U\,H\,\,9\,D\,O\,X\,W\,D\,]\,L\,R\,Q\,H\,\,R\!S\!O\!H\!L\!D\!F\!C\!D\!D\,D\!S\!N\!U\,M\!R\,16\!S\!N\!L\!D\!L\,F\!R\!R\!L\,Q\!H\,\,Q\,H\,\,$

35(0(66\$

3 HU OD TXDOLILFD]LRGOLHXDQQYIPVRDRHBDDDFORHqGILRVOSORDURUHHQVO'L PLV>YHORFLWjHGHOODGLUH]LRQHGHOPDHO

\$ TXHVWR VFRSR 7HFRQ BIJO LTD SKRDVLPJLL FX QQ HHG JALQD D& TRIPP LHV VG HL QQ VD W L UXQD VWD JLRQH DQ H FWRHP SIDWUUW FIDG IHDOF HVQXR SDWULPRQLR

/D VWD]LRQH RSHUD VHQ]D VROIX JOLHRLQWHIH GILL WFROLLW GQXLQWUUHDOL]]D]LRQH GHOO¶LPSLDQWR LQ R\$JOJHDWOWRR LUOLF3DUGRHYOLWQFFLQHGOLFORDF%DVLOLFDWD

, O SUHVHQWH GRFXR® BIQEVLROHULHOV ROOG ORNOSHOVG R YOLDOO XOWLDH JORD QILH GHOOLULSRUWD L ULVXOWDWL GHOOH HOOVELRWIJD JLLDRECHLROYW ROOWDHOO YD XLV OWDD YN 5LIHULPHQWR & RGLFH 5,) FRQWHLHOOHOOD BY WOUS BS YOLU HOFFF KE DDU WO XWUWHH XLLWWL GL LQVWDOOD JLRQH TXHOOR GL PDQLXWWXH LOOR JQRHQ EI HVOWO YID RTUXGLLWQLDWURLUDH YHORFLW J QRQFK P LO FHUWLILFDWRROOLW EI BIODL EI OD EI JLURLOY HI OOWLD TQXHH VOWH OW WUDQVFRGLILFD H GL YDOLGD JLRQH GHL GDWL

\$0 ILQH GL VWLPDUH OD YHQWRVLW; ISKHHULIROGWRHWIHVOYDSULROFHVOL VWRULFL]]D]LRQH GHO SHULRGR SUHWIRJB GIHIOHOU¶LIPOHWQHWURD FIHGILBIQOWLH ROWUH DQQL

/\$ 67\$=,21(\$1(020(75,&\$

/D VWD]LRQH LQ RJJHWWR q VWDWD LQ\qWB\CXO/DWWDWLXQL\CXDDWDGD G¶DFFLDLR VWUDOODWR GL DOWH]]DWB\DUU\WDLFKHPG\HO\CXHJLQ\SF\$L\B\D\B\EF LQL]LDOPHQWH VXXOWDB & DVOHO\DVDVFKKHKGBV&QQRQOXHWD\DXDHJQRXQ

7LSR GL DSSDUH	\$OWH GDO V	0 D U F D	0 R G H O O	0 D W U L F	ROD	
6HQVRUH GL Y	'HORFLWj		15*		&	7 *
6HQVRUH GL G	LUH]LRQF	ł	15*		3	7 *
\$FTXLVLWR	J H		15*	3/86		

& RPH GD VXFFHVVLYR UHSRUW GL PODDQXXWVUHXQPJHLQRWQDHJLRDQQHFKF¶RK VRQR VWDWL DFT&LVSWPQLLEGODWSHUXHRVQXRHVXWRHJVXWHXQGVLR

7LSR GL DSSDUF SOWH	0 D U F D	0 R G H O C	0 D W U L F	ROD	
6HQVRUH GL YHORFLW	j	15*	3	•	
6HQVRUH GL GLUH]LRQ	Н	15*		3	7 *
\$FTXLVLWRUH	6	(&21':,1'	120\$'		

6HGL RSHUDWLYH 9LD 0DWWHRWWL 7HO ±)D[

± 6 & \$ / \$D 13 G±R QQHW9 D O± 7 U R P S L D % 6

6HGH /HJDOH 9LD 0DWWHRWWEDUGREQH 9DO 7URPSLD %6

6 W X G L R D Q H P R OUTHJOLIFTEL 61 DSU H 9 D O X W D] L R Q H ROOHLOF OOD DD 3/VU/R 16 W D L R Q H (

/DGRFXPHQWD]LRQH WHFQLFD GHHLGVDHWQVRPWDLWHDGGHDGFRVWUXWWULFL q UHVD GLVSRQL\$EOLODHHJDQWYGHOGDO BIDVFWFROVWRD DUOLGSRJUDWWDRVSDUWH FRPH GHWWR LO UHSRUWDILLQRLQLHDOOHHGVLFKEQGWYDEOLOPDDIQRXQVHHQGHLHG L FHUWLILFDWL GL FDOLEUD]LRQH GHL VHQVRUL GL YHORFLWj

/D VWD]LRQH DQHPRPHWULFD EHQ UDSRSWLHRVHFQWHDRXXXVDOCSVRHU]LFRRCCCI XQ FULQDOH VHQ]D RVWDFROR DOFXQR LQ RJQL GLUH]LRQH

/H FRRUGLQDWH GHO SXQWR 16-ULLVPWLLFKKHU 106 HO W LWWLRY FRK VWD]LRQH VRQR OH VHJXHQWL

- 9 & RRUGLQDWH VLQVPWHHVP DIL8 Q0H O*6) X V R /RQJLWXGfLQ帽 (/DWLWXGFLQ¶ 1
- 9 \$OWLWXGLQH POP
- 9 2URJUDILD GHO SXQW&UCLQDONWDOOD]LRQH
- 9 2 U R J U D I L D F L&URFOROV LMQDDQUMHHO R Q W D Q R
- 9 8 W L O L]] R G H3 OD WF HR LOURH Q R
- 9 2 V W D F R O L Q H O O H L P IP IHI VG VL XD QWRH Y L F L Q D Q] H

6WUDOFLR LPPDJEQQ XEWFDQORQ WBOWHPDSJLDRQQWRHHROLFR GL SURJ

9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF % LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

6HGH /HJDOH

(PD<u>LOQIR#WHF</u>QRJDLD LW (PDLO <u>BQ&R#SHF WHF</u>QRJDLD FRP

6WXGLR DQHPROURHJOLIFFRLOGIDSUH 9DOXWD]LRQHROOHLOFOODDD3WWROGWDLRQH (

/D VWD]LRQH DQHPRPHWULFD QHO VXR SFURLPOSFOLHSVDVORL WULHVTXXOLWIDWFGGHOOD QRUPDWLYD YLJHQWH ,(& VLWLY, DQPSHDQUVWHLFVRVODDWULH YVHRUOLRL SE

- X LO GLPHQVLRQDPHQWR BILOFFRQLWHDQJWLDRPWBHQJYCSRIWWNRRPEDLOWYR
- X OH SURYH GL FHUWLILFD]LRQH GHOOHDLQXFDIUFWDHO]IJEEUSDUJERSQUEL SURYH HIIHWWXDWHWEQGEDTOPFIRUVDWDUXWWOQFUUHDSSEUXHQXFFQFWSDLWRLY
- 1 HO SURVHJXR YHUUDQQR GHVFULWWD]LLFSOUHLODFOLHS19DFORHFWRLPLSFRDQHOQ
 - , VHQVRUL DQHPRPHWULFL

,OVHQVRUH SHU OD PLVXUD GHOODU¥HÐOOREFJLDWYJRG 61 DOODDQWFRF & MW & OD [LPXP \$QHPRPHWHU & DOLE UDW DHOOGLE (UVDWFR qF 68 61 OY DWOLRSUFH DG LPV HIRQGR VFDOD GLPV HVVR IRLUHQ IGVLF HP SVX (UDDV PLLVX 160, XV 69) JJOHDQOHHU DOOD YHORFLW JGHO YHQWR & RSLDR 166 69 100W PDH 13 TOV 68 100_FFLTDAFWLFX WIGHE WOFFD\$103 11L FF7U IGUV SRQLELOHV RIKHHOODDD OF ILWFD 100 X0 WHQ]LRQH

/D PLVXUD GHOOD GLUH]LRQH GHO YIHHQWWWRXDSWHU WYXDWIWUGIDOWHDUDLOO 3:LQG 9DQH FRQ OD EDQGHUXROD FIKRHPHJWWRROLFGLDUGFROFDRUCH XFOKHSF YDORUH GLUHVLVDWUHLQFDLOHHOHLOVWXUQJFLBROOZH GGHOOOODDESDROVGLHUXROD QHOO ULVSHWWR DG XQR]HUR FRQYHQ]LRQDOH 1RUG

/¶DFTXLVLWRUH GDWL

2 ULJLQDULDPHQWH OD FHQWUDOLQDP\$HWWW 10FID FXTWXLLOVIL]]]LDRVQDH QGHHQLO PLVXUD HUD FRVWLWXLWD GD XQjUIBIJL 16 WW QUFDFWLFQ ID WW R SUR GIFB W WFRX IJUDGR GLUHJLVWUDUH SUHHODERUDUDHW HFDP 19 BIJDUJ PLQQQDHUJHJHV XILFDHHPYFD QGLUHJLRQH GHO YHQWR 6XFFHVVLYDPHH QGWHOD QD HVOWD ID PLFREQLHWR V GHQ QSIVR VWLWXLUH O¶DFTXLVLWRUH GDWGIR FIRHQW IJ H6JHLFVRVQUGD LWQRQJ HG HSQUFR FIRHQW VLVWHPD FDPSLRQD OH JUDQGH]]H RJQLWWHUFYFDQDQGFR HGLUHJLFVLVQUXDWLFR JUDQGH]]H

- 34 9HORFLW | PHGLD GHO YHQWR
- 34 9HORFLWj PDVVLPD GHO YHQWR
- 3/4 9HORFLWj PLQLPD GHO YHQWR
- 34 6FDUWR TXDGUDWLFR PHGLR GHOOD YHORFLWj YHQWR
- 34 6 HWWRUH GL GLUH]LRQH SUHYDOHQWLHFBBDVIDE CURLODHND DQWI f FRQ OR]HUR D 1 RUG HG LO VHQLVRY BUVURR (WDW)LRQH RUDULF

6HGH /HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6 &RG)LVF 3 .9\$

6WXGLR DQHPROURHJOLIFFRLOGIDSUH 9DOXWD]LRQHROOHLOFOODDD3WWRK6WDLRQH (

- 34 6FDUWR TXDGUDWLFR PHGLR GHOOD GLUH]LRQH GHO YHQWR
- 34 7HPSHUDWXUD PHGLD GDWDORJJHU
- 34 9DORUH PLQLPR EDWWHULD
- 34 9DORUH PLQLPR EDWWHULD
- 34 9 DORUH PLQLPR EDWWHULD 9

/ DSSDUHFFKLDWXUD q DOLPHQWDW DDWFRHQ GGDX HX CEDD WE DWWH WILHHULHD 9 FRUUHGDWD GL UHODWLYR SDQ ORHQOROXRQ MIRDWX RXVRRQORWPD DFWRX STHKUHLBYDUHIG GLPHQVLRQL GHOO¶ DFTXLVLWRUH VROPRP PHROCO WU OR SILH GORW WGHL FLU[FD [GLWHPSHUDWXUD GLIXQ] LRQDPHQWR q FRPSUHVR WUD H f &

/H PHPRULH VWDWLFKH FRQWHQJRQR QROCHNYJUHH UDLIO HGYDDWWLH UBLOD IB QUBLOQIRUPD]LRQL TXDOL LO FRGLFH GVHWO WD IDD]LVRWQDHJLRO OD HG IDL WO DS HOU IRRUGDR HG IL COFKH VHJQDOD OH HYHQWXDOL DQRP EQODLPH QUWRFR, QDWSUUDHWOHLHGYXRU IDG OB WO HG IDL VG LXQ RSHUDWRUH DGGHVWUDWR FKH DL QDHUHHJILHP WFWGXLDI XWOOJ OL RI QROSPHHUQDWJI FRQ FDGHQJD DOPHQR PHQVLOH HG LQ VLWR FRQ FDGHQJD WULPHVW

/ DSSDUHFFKLDWXUD q IRUQLWD GKLHXSQHGIPHSVOWDH DODFU'ILWWXDODDIJDQQLQDEQHWJHH WYDWYDVQWqDQRHYVDEEEQDDOCHWJHH WYDWYDVQWqDQRHYVDEEEQDDOCHWJHH WYDWYDVQWqDQRHYVDEEEQDDOFXQH IXQ]LRQL HFRLGVIXEDBOLJQDHUCHODDO V OW DR]WURQHH L OVDH BSW GL FUHJLVWUD]LRQH

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*(67,21( '(//$ 67$=,21( $1(020(75,&$ ,1 6,72
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/D JHVWLRQH GHOOD VWD]LRQH DQHPRPWHDWQUJDF19HdJ GOLD IRRQGVD'ER TXDOLW J GHL GDWLHYUHLOHHVYVDHWJLH FHRVQVGDROBHWDSGSBVSLHWUDVPRHQQDWH DGGHVW FDGHQ]D DOPHQR WWWLXPBIVLWQUVDLOWHRHOJHHVHJXHQWL DWWLYLW

- % 9HULILFD H PDQXWHQ]LRQH RUGLQDUULBD KGHVOROVDWHYJWQDR]LRQH D
- % 9HULILFD GHOOD YHULVLPLOLWXGLQH GHL VHJQDOL LQ LQJU
- % 6HJQDOD]LRQH LPPHGLDWD GHL JXDVWL ULOHYDWL
- % 3LFFROL LQWHUYHQWL GL PDQXWHQ]LRQH VWUDRUGLQDULD
- % & RPSLOD] LRQH GL XQVDJR/OF Q R GGDD GLLQF R-DDDUDHE R OD DFJ H R Q Q W H U R G DGWLL
- % (YHQWXDOH VSHGL]LRQH H ULFHYLPHQWR GHOOH PHPRULH

) D S D U W H G H O O D J H V W L R Q H G H O O D VUVVDDR] W BS Q Q D D D Q D K FH R Q D O M D Q D N D I Q W L Q W H U Y H Q W L G L U L S D U D] L R Q H V R V VQ L S W H X U L HR VQ W D C P H D Q O W H D I S X SQ D W R I G E F Q W D L

9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF % LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

6HGH /HJDOH

(PD<u>LOQIR#WHFQ</u>RJDLD LW (PDLO <u>BQ&R#SHF WHF</u>QRJDLD FRP .PSLDQWR HROLFR LQ ORFDOLSWOLDHORSHOUTUH QHO &RPXQH GL

6 W X G L R D O H P R (D)RN,D,LERRL (Q) DSU H 9 D O X W D I L R O H RSOHLOF(0) DD:3WLMR (G) W D L R O H (

JJ GL ULOHYD]LRQH H Qf

1HOOR VSHFLILFR DO GLO; GLE**RHPD**D]LORVQHUGLXJKRQEFSLHRUVSXULRVE QRUPDOL DWWLYLWH; QROPDYQXUWLHOOH]YLDROOQRVLSHHUUDOWNBQQRRUFLRGL GL SHUGI

6L VHJQDOD FKH LQ GDWD q V WQD) MARDQ HHI I MHWWUMD XR DU WG D Q XD QU II VRVWLWX]LRQH GHO VHQVRUH GL YHORFVLRW/jWLLWQX]GBOQ/HD GHO GDWSD+ q VWDWR QXRYDPHQWH VRVWLWXFLRWFFH LOGDDVWHSQHVFFLUILHFKGHL WFF PDQXWHQ]LR\$QOHOHYBIGVIR\$

/(7785\$ 75\$16&2',),&\$ (9\$/,'\$=,21('(, '\$7, 5\$&&2/7, ,1 6,72

WUDQVFRGLILFD H TXLQGL LQ IRUPDWR OHJJLELOH

6ROLWDPHQWH L GDWL UHJLVWUDWLWGHDOLOFFIDFXDVJLWQUDHWHL SQUFI DVSRUWDELOH YHQJRQR LQYLDWL YLODD* 6POH P3R5U6LDR 1P10 HQR WWLUFDV ISHWH GHOOD VRFLHW | LQFDULFDWD SHUVHDV 16 HH 10D HD 16D HD WR WYR H G DDEURFUKDL | YLIRDQWF OHWWXUD GHOOH FDUWXFFH H GHLPIHLGOLHDQVWDIVPRIIWWZLDWJHVWDHVFDLIHLIR GLWWD FRVWUXWWULFH FKH SHUPHWWHDOWDL WODDXQOVFIRROGIPIDLFVDR OG)H YDOLGD|LRQL DXWRPDWLFKH VXERUGDQ.QSIWHH YDDDXXXDDGDGTDGHLDRJXQQHRVWLFD G 1HO FDVR VSHFLILFR VL KDQQR D GL& BGVEHLRQQH QQ IRJUPXD9V6R 16LQ GDOO¶DFTXLVLWRUHVHXQURHSJHLUVWRJUQDLWBRAR FFLKON/FXFORRUUDGVXSQRQJKSURLR ILOH & RDS LTFXHHFOVOYL FRKUHLJERQUDUULVSSRR

4XHVWL GDWL UHVL GLVSRQLELOL DDQF&KRPIPFMWHWGHQOVOHDSQHRUUFPBCG/GLY FRSURQR XQ SHULRGURLDHLUKYQFDRQQRDLDVLHSJHXUHLQRVGLLVLQJR

1 <i>f</i>	1RPH ILOF	7 L S R	'DWD LQI	'DWD ILQH
	65,) B	\$6&,, &RPPD 6HSDU 9DOXHV		
	65,) B		DWHG	
	65,) B			

6HGL RSHUDWLYH 9LD 0DWWHRWWL ±)D[

± 6 & \$ / \$D 13 G±R QQHW9 D O± 7 U R P S L D % 6

6HGH /HJDOH 9LD 0DWWHRWWEDUGREQH 9DO 7URPSLD %6

 $6\,W\,X\,G\,L\,R\,D\,Q\,H\,P\,R\,D\!U\,R\!H\,J\!O\!L\,L\!F\!R\!R\!L\,D\!H\,D\!S\!U\,H\,\,9\,D\,O\,X\,W\,D\,]\,L\,R\,Q\,H\,\,R\!S\!O\!H\,L\!D\!F\!D\!D\,D\,S\!W\!U\,M\!R\,I\!S\,W\!,\,D\!D\,L\,R\,Q\,H\,\,($

/D VWD]LRQH GL 5LIHULPHQWR QHO SHUHLGRGGR FRPSUHVOR WWW.DDWLDO GHOO¶DFTXLVLWRUH 6(&21L:,1FX1L20\$G'DWLLIGFROS RSHO) DXQWSUHDUQRVGFRR FDPSLRQH KDQQR LO VHJXHQWH DVSHWWR

, GDWL VRQR VXGGLYLVL LQ EORFFKL WRIPPRS FIQEIO HIG OX DO OR OU PR X Q I HLVFFFKH L GDWL UHJLVW UDWL QHOOH FWOOR QQH KDQQR LO VHJXHQWH V

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f FROR	'DWD PHVH JLRUQR DQQR R	6 H F R Q G R	2JQL PLQ	x W L
f FROR	9HORFLWj PHGLD GHO	PV	2JQL PLQ	K W L
f FROR	9HORFLWj PDVVLPD GH	PV	2JQL PLQ	K W L
f FROR	9HORFLWj PLQLPD GHO	PV	2JQL PLQ	K W L
f FROR	6FDUWR TXDGUDWLFR PHGLI	PV	2JQL PLQ	K W L
f FROR	'LUH]LRQH PHGLD GHO	JUDGL VHVV	2JQL PLQ	K W L
f FROR	6FDUWR TXDGUDWLFR PHGLR	JUDGL VHVV	2JQL PLQ	QWVLR
f FROR	7HPSHUDWXUD PHGLD G	JUDGL FHQ'	2JQL PLQ	K W L
f FROR	9DORUH PLQLPR f EDW	9 R O W	2JQL PLQ	k W L
f FROR	9DORUH PLQLPR f EDW	9 R O W	2JQL PLQ	k W L
f FROR	9DORUH PLQLPR EDWWI	9 R O W	2JQL PLQ	k W L

8QD VXFFHVVLYD WUDQVFRGLILFD PHGILIÐIQQVRHJDSILDRJÐIÐIQPHGSWIHIGGLIVLQ XQ IRUPDWR VWDQGDUG LQWHUQRIGLDILLFOXHLYEKDHWLDUDQQR SRL YI 8Q RSHUDWRUH TXDTOXLLQFGOLWBQSOLDRFIÐIOWHLGDVYLLROQLHJJDSOLDRFBORKUDDPPLFRQWUROOR RSSRUWXQDPHQWH SUHGLVFSRRQWWLURO7ODROHD RYSLMWDDWORHUGJUDQGHJJH QHO WHPSR FRQIURQWDQGGRWLL UGLHVOXODDWDWHLVFVRDQVTVXDHJDLOGSUHVVHQWL FRQ GDWL FRQWHPSRUDQHDL GW ĐOWLDH YRWDJDLRQ&RX ELQFURFLDWR Q SRWHLSEULHOVHHQQHGLGYLLOGADRFPDDOOIXHQJGRRQXDWFHQWR GHOOD

6HGL RSHUDWLYH 9LD 0DWWHRWWL ± 6&\$/\$D (3 G±R)QQHW9D Q± 7URPSLD %6 7HO ±)D[6HGH /HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

(PD<u>LQQIR#WHF</u>QRJDLD LW (PDLO <u>BQ&R#SHF WHF</u>QRJDLD FRP &RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

6 W X G L R D Q H P R OUTHJOLIFTEL 61 DSU H 9 D O X W D] L R Q H ROOHLOF OOD DD 3/VU/R 16 W D L R Q H (

6XOOD EDVH GHOOH LQGLFD]LRQL GWHFOHOQ¶RHSGIHIDWORXURHJKOLRGDLOSHUHRYGH

3HU OD VWD]LRQH LQ RJJHWWR VL VLRQOWRH WYHYOLWQLHGHLVYODUFLLQIDJQRQQ GLVSRQLELOLWJ GHO GDWR YDOLGR SHU L q PDHWWLXODIO PXHOQJWLRIQSDDPUHU GL TXHOOL GLVSRQLELOL

&RGLFH	'HQRPLQD]LI	'XUDW PLVXU	3 H U L	RGR GL PLV	''LVSRQLI	ELOLWj
5.11.5.21.1.		PHVL	, Q L] L R) L Q H		
5,)	5LIHULPHQ	W R				

(/\$%25\$=,21(',\$7,\$5&+,9,\$7,

& RQ L GDWL HOHPHQWDUL GHOOD YHDDWREYWJDHG GLQUWHJUNKQHDOGLH PLQXWL YHQJRQROHDEHRWUDYJLDRWQHLOFKHHHFXKDQOYLHIQFWDRUQHRLGOLVLWR GDO DQHPRORJLFR

, ULVXOWDWL GL WDOH DQDOLVL VW WOV WOEN WOOFFID HV RQOHR. UDIS ISLF QH\$0000¶HJDW RBQ\$D JXLGD DOO¶LGQLW HWUDS OOHLW BIJLLR QGERLWO HW DOOP¶UOHLYJ IDR QG HIV VRSUD FLWDWR PH VQLW UHS QB HIV OW DV QB BX XEDRAWURS UULFQOFLL SF DROQLV LHQDHDUDW H

'L VHJXLWR VL ULSRUWDQR LQ VLQWXHOVOL¶DHOODEDXEORLUDS)DLWRQHVXGOHOLDG'10'

&RGLI	'HQRPLQD]L) X V	/ R		V	0 P	\$ O W H V R V \ P	3 H U L , Q L] L F	RGR VWD]	LRQH
5,)	5LIHULPHQ	$WR\ f$	¶	(f	¶	1				\$ W W I	. Y D

6HGL RSHUDWLYH 9LD 0DWWHRWWL 7HO ±)D[± 6&\$/\$D 13 G±R,QQHW9D Q± 7URPSLD %6

&RG)LVF 3 ,9\$ &DS 6RF ¼ LQWHUDPHQWH YH ,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

6HGH /HJDOH

(PD<u>LQQIR#WHF</u>QRJDLD LW (PDLO <u>BQ&R#SHF WHF</u>QRJDLD FRP

6WXGLR DQHPROURHJOLIFRELQIDSUH 9DOXWD]LRQHROOHLOFODDD3WUMRK6W,DLRQH (

, ULVXOWDWL VLQWHWLFL GHOO¶OHOOD DVENROUJD IRLORHQFI XVLWFDRVQLWLWGIHFUDD VO HODERUDWR VRQRL VHJXHQWL

&RGLFF	'HQRPLQD]L	3 H U L F	+ PLV	9 PH	(QHU			JDP /ULE:	K]LRQH
		PHVL	V O	PV	: P	9 F	Р	N	
5,)	5 L I H U L P H Q W R								

&XUYD GL GXUDWD GHOOD YHORFLWJ GHO YHQWR

9LHQH LQQDQ]LWXWWR FRVWUXLWD KOHD HFVXSUUYLDP KB LL CG XWUHDPWSDR VGSXHJUL XQ GHWHUPLQDWR YDORUH GHOOD YHORFLWJ GHO YHQWR YLHQH VXS

7 DOH FXUYD q LQ JSH-SQUHHUVDHQQHWDEWQ PEIGX PLORWQHI XGQDS CIRVEDVEILGELW j OD FXL FXPXODWD q GDWD GDOOD IRUPXOD

GRY9H9PHG q LO YDORUH GHOOD YHORFLJW9, QHODD SQHIUFHQLWQXXDWO IFRPSOHVVLYR LQ FXL WDOH YHORFLW YLHQH VXSHUDWD

'L W D O H G L V W U L E X] L R Q H L 19, RGUIL F IDD WY IBH Q JWR ID) RD W IBV IDPWI S D U D P H W U L L Q W U L Q V H F L F L R9₉₇ O H D LYO H O IRD RW LWWYR IEP BH U GOLWID WU IRW WHIP WD WY JL IEP BH V V L G D W L V S H U L P H Q W D O D IDOS, SQ OH ID FUDL WY IDD] IGERXS] IRI R GQ H HO YO WD HOYLXADW U

7XUEROHQ]D SHUFHQWXDOH GHOOD YHORFLW; GHO YHQWR

8Q DOWUR SDUDPHWUR VLJQLILFDW LLYFRH Q WCX DQ MW H7Q GY LH 100 / DG LY MWC RU GHILQLWD SHU RJQL LQWHUYDOOR GL PLQXWL FRPH T 100~sgV(10')/Vmed(10')

GRYWLJ9 q OR VFDUWR TXDGUDWLFR PHGLROULLQDRWULPYDRJLDROQOH LVOXWO HOLD YUVOXWO H

5DSSRUWR GL UDIILFD GHOOD YHORFLWJ GHO YHQWR

8Q XOWHULRUH SDUDPHWUR VLJQL*I*LGEBIOVO DRY HOLROFU VO S SGRHUOW YRHQLI RJQL LQWHUYDOOR GL PLQXWL FRPH R maxV(10)/Vmed(10)

GRYP*TD[9* q LO YDORUH PDVVLPR LVWDQWDQHR FLDOPXSWLBQD(WVRR DOG) O LQIRUPD]LRQH VXIDFODD LPVDWDVQDFVDD QUHBNDQ WGHROOOD LYQHWOHRUFYLDWQO O R

6HGL RSHUDWLYH 9LD 0DWWHRWWL ± 6&\$/\$D13G±R,QQHW9DQ±7URPSLD %6 7HO ±)D[6HGH /HJDOH 9LD 0DWWHRWWEDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

*UDGLHQWH DO VXROR GHOOD YHORFLW; GHO YHQWR

4XDORUD VLDQR GLVHSVRLQPLRELVORLVWHXJOQRPHGXHIOP£RVFXHDWHjDGLGXH GLIIHUHQWLK DHOKWBJDJED VXROR q SRVVLELOH VWLPDUH RLEDLWYDODROUMIXORKO DOID 7DOH LQGLFH SHUPHWWH GL]VRWGLHRODDUYDHWUBDRDJHHYQWHRODBLFWDWFJ VXSHULRUH DOO¶DROQWHHDJQHOPIROPENDOUWLWFDHJLVXGODDUVDLEDGVH OFHQWR PLV GLYHUVH

/D UHOD]LRQH FKH SHUPHWWH GL VW**Y.8RQHQYJLDDOOHHYHKGOR**qF**UW**\$RqU VHJXHQWH IRUPXOD

GRYDHO ΔOLO JUDGLHQWH GHOOD YH Ø RHPOLWY ROOHRO OYHH QYWHRO ROFOLW X ROOHRO YH FRUULVSRQGHQWL MXOHWYH]]H GDO VXROR

\$YHQGR TXLQGL D GLVSRVL]LRQH OHYHUQOVHRYDD]LGRXQHL DGOHVOHO]DJHYGHD SRVVLELOH VWLPDOUHD LVOSHWUDLOPRHUQHWDSOLSHDQQPWLRYXOUDWLQVOWHDOOOOD]LRQH GHO YDORUH VL RWWLHQH GDOO¶DSSOLFD]LRQH GHOOD VHJXHQWH IRUPX

alfa OR/JV ORhJh

&RQWHQXWR HQHUJHWLFR GHO YHQWR

3 HU TXDQWR ULJXDUSGUDR SOUDLYD SPHINOLWRI BIOD WHU UHHOVIL FSRD LAJWLOFFR O DUH L SRWHQ]D VSNyF LIDLWF BIVD FRPH SRWHQ]D FKH IOXLVFHFLDHW WHU SDRYHWU D SHUSHQGLFRODUPHQWH9D DOVWHDQOW BLDGWLDY BID RFLW j

$$P_V = \frac{1}{2} \tilde{U}V$$

GRYKH q OD GHQVLW j GHOO DULD FKH QH**DO** HYDHOOD BUERR UFDKJHLR VQLL WH.
FRQGL]LRQL VWDQGDUG GL S**U** HIV225. KQQMH H WHPSHUDW XUD

$$E_V - \tilde{V}\overline{V}$$
 T

GR \overline{W} H q OD YHORFLWj PHGL \overline{D} qF \underline{K} Θ L \underline{S} H \underline{D} U \underline{G} , \underline{R} \underline{G} RVL \underline{G} W, \underline{R} X \underline{G} DQQR RUH

0 ROWLS Ø LEBIQ GORD V X6SCHLOILUFIR HW RUH GL XQD PDFFKLQD HROOLFD V FKH WUDQVLWD DQQXDOPHQWH DWWUDYHUVR LO GLVFR URWRULFR

6HGH/HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

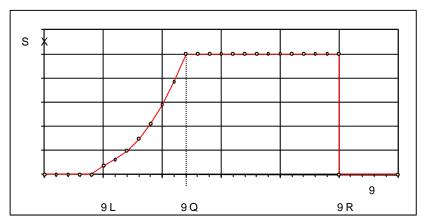
(PD<u>LOQIR#WHF</u>QRJDLD LW (PDLO <u>BQ&R#SHF WHF</u>QRJDLD FRP

(QHUJLD SURGRWWD GD XQ DHURJHQHUDWRUH

/ HQHUJLD HIIHWWLYDPHQWH SURGXFLELWOXHWFWRDQYLXDQVJRHOORHUXDQWDIGHOO HQHUJLD VRSUD LQGLFDWD , OD 36ADOUFRVOLFTREDIDWH OLDQ SIRVWIFILQFLIDQHUVDQWDDUDLQGGLDPHQWR PRGXODWF LVWDQWDQH**D** & ELOD & ELOD & ELOD WHRQWR FXDEYLEFHRQDYO & QUDLQGGLDPHQWR PRGXODWF GL SRW&HSQSJWUH GLSHQGHQWH GDOOD YHORF%LMWWJH 8DULV & SHULRUH DO

$$P_V = \frac{1}{2} C_p \sim US V$$

, O SURILOR FKH QH ULVXOWD FXUYKOLQID SOR WI BHQFIBIL CGID II BO LOGID II BO L



'DWR FRPXQTXH LO SURILLO JURH COSHHOO DEEDLOSHR WGHDOO) OO D PDFFKLQD SUHYHORFLWJ GHO YHQWR LO FDOF/RGOSHHOO OF DDFSFUKROQXDFKELED DWJD DOQHOOX ISS XVL HVHJXH LQWHJUDQGR ULVSHWWRWDRO OV DDDYHOOD DYHOOD RSEWIJH QGJDO JYHOODHWUB ELLO SUREDELO LWJ GHYOHOODWYRHOO PROFLWLJWGRHED RQVLGHUDWR

/D YDOXWD]LRQH GHOOD SURGXFLELDOOLOWR, GBYHH 6) RF HW H OF HDOO FYRHOOG OF PRIJR GHOOD PDFFKLQD XWLOL]] DEGLOHRQ LWOHY G 6) ROUGHD AP AN WHE WE WE XOWHULRUH DIILQDPHQWR GHO FDOFR OR RW 6) RYGUHH GE HV LWWH RQHUF KFIRR Q TOWN SURSRU]LRQDOL DOOD YDULD] LRQH GHOOD GHQVLW J GHOO¶ DULD

/D SURGXFLELOLWj QqLMVQDVQMRDDQVVQHFRQXSDHDQXXPDHURRUGPLRWUHHLHTXLY JHQHUD]LRQH D SLHQD SRWH(Qs) (Dy AGAD/WARD Q6 PyO UDSSRUWR

9LD 0DWWHRWWEDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

(PD<u>LQQIR#WHF</u>QRJDLD LW (PDLO <u>3Q&R#SHF WHF</u>QRJDLD FRP &RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

6HGH /HJDOH

 $9\$/87\$ = ,21('(//\$ 9(1726,7\$\P', /81*2 3(5,2'2)))$

/D YDOXWD]LRQH GHOOD GLVWULEX]Q R Q HR GSHOUCLDR CYRH QL RQF LX VQ J VQL HW DOO¶LQVWDODD]LRQH GL XQ LPSLD QOWORD HVRX OD LF RIOR FSLLW) J VPH PGSLODL FVRWPLHPQ XQ SXQWR LPSRUWDQWH SHU OD FFDDU B RW QV HX LQL [D] FDFJ H RVQWHD ES LHOOHO DJ ULDL GLYHQWD HVVHQ]L ISS QR LQL TEXLDOQL GWR, GD IDD LDGGSSDHWULL RG GQL LOFL WWDHWP ISS R FRQWHQXWL

, Q JHQHUDOH OD VWLPD GHOOD YHQFVLF;]VDLJWF, QGHL ΘΧΩJHRV SHIWULFRING XWLOL]]DQGR L GDWL GL YHQWRVLVD; RULSOLH YVDWWDL]LSRHOUL GDLQYHHPURVPLHDWOUQL PHWWHQGR LQ FRUUHOD]LRQH L GDWLOHULVOWHPYDWHL FFROQ W 7HP 9 POUD ULQLHODHPV VL YXROH YDOXWD U HOOD Y CELLO CEDF LFRWQ;IURPQHWOFULHD GHGYLR SRVVLELOPHQWH QHOLQHLFQHBGRHUNRLJPUHDIFLFFOEGE CEL MYSQRWWLL]LH GLVWDQWL LSRVVD LSRWL]]DUH VLDQR VRJJHWWHFROPJXOQLTXHWHSVRWLVLUEHLJOLFIL REHLGYLDDQN FRUUHOD]LRQL YHULILFDUH OD YDOLGLW; GL TXHVWH FRQGL]LRQL

1 H O QRVWUR FDVR SHU OD VWRDYLJLRRQHH GFDRWQLVULLGHHUULE FDPSDJQD GL PLVXUD GL PHVL 7DOHXGIXEDHWQDWEIRSQHDYLSHRQWHHUULWFRH YHORFLWJ PHGLD UHJLVWUDWD FRPH TLXHGOLOVDSRGQLHQQSENKUHLBGEIBOH VWRULFL GHOOD PH5GJHVELREID KVDWDXJQDQQEXUDWD GL ROWUH DQQL GLUHWWDPHQWH LO SRVL]LRQDPHQWHRDWFWHRUUGFHRO©EEQDIDDWGRQXDOLWJ S

3 HU FXL SHU OH YDOXWD]LRQL GL SURIGE XO]LLFRRQ KG HDOW WW LHW BO GADL X YHORFLW J PHG5L,D) BOTQ QWX BEWGDLOH D PGDO VXROR XJXDOH D PV

9\$/87\$ = ,21('(//\$ 9(17,2\$ \$ \$ P '\$/ 682/2)

1RQ GLVSRQHQGR GL VSHFLILFKH ULJ PDCH YGDD JOLRACXIR CER YSHO R FDLW J FD CYHULILFDUH XQR GHL UHTXLVLWL DUXLWF KRUHLY JMD LW SYHRU SLUQR F XH KG WHW FI EQDH YOFO GDO VXR OR NO FP VO FP QV Q SRVVLELOH GHILQLUH O¶LODY JUHFCQVHLWF, FC QH OO¶ YDHXOV W SDUDPHWUR GL JUDGLHQWH DO VXROR DOID

7 DOH JUDQGH]]D q GHWHUPLQDELOH THXGDHOVR 19 R VRDY QWRHJQQLRV SQLXQHE YHOR 19 LW9, D GXH GLIIHUH KQWMK DROWYHIJI, R TXDQGR VL GLVSRQH GL VLPXIOXLGRGLQDPLFR FKH VWLPDQR GHWWR SDUDPHWUR

& RPH JL j GHWWR QHO & DS OD **UH** COODD] LYRHOOHR FFLKWH**, SHO**I PYHHWQ DOWH]]H GDO VXROORHOQ]OLBIO HWHLSRQ HUMLBSBRXUHWQDWMHDIRQUHPOXOODD

V V h h

GRYDHO ADLO JUDGLHQWH GHOOD YH Ø RHÐLWIR OG RHOO HY HYOHWO R FOLOW jV & RIO RY HQ FRUULV SRQGHQWL KKOHWK H]]H GDO VXROR

6HGH/HJDOH 9LD 0DWWHRWWtDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFLI

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6WXGLR DQHPROURHJOLIFFRLOEIDSUH 9DOXWD]LRQHFOODDD3WWRK6W, DLRQH (

1HO FDVR VSHFLILFR SURLHWWDQGRGDV&OODVLWWYDHJRLORLOFR LD GEBING PRGHOOR GL FDOFROR:\$V3 FKH IRUQGLMFDHDXQYHFODRPFSLRWWYGHGGLFFHQWLRREGL GLVSRUUH GHO SURILOR GHOOD YGHDOORFVLXWR,ORRHGSLRDVDDDDHR YYDHULLHUSRVL]LRQL GHO OD\RXW GHOO¶LPSLVDODWRRUGFDDOGR&QROORH LVRYHQWR G

& RQVLGHUDQGRWXDWWRLULLDOHYUBXOIRSODHEU9IGDERULVXPOWWD

, O UHTXLVLWR ULFKLHVWR GL XQD YHQOLR ÐLOÐ Ú, PHPG VLDDDQ OPX DS DOÐH ULVXOWD VRGGLVIDWWR

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, ULOLHYL VSHULPHQWDOL GHOOD DYHPOLRIKUWO JLORHQOH YHRQOWRR RIFIR PEIF GD LQFHUWHJ]HOERKUHWLS BIHYOV RS BIVRVQ BAQULBOUHFDHWHVH & JUHZ TFXRDQVHQWH GULVXOWDWL FRQ DWWHJJLDPHQWR LYOWLD WSWLRIW DE BOSLHYWW IF RLQ VFLLORHQUDLQOO GL FRQILGHQJD GL XQ SURFHVVR SHUPRHQWHWHR GULL WXDOOWKDWD RUH VTDXUDJOYHH SUREDELOLWj

1HO QRVWUR FDVR FRPH VXJJHULWR GDOODDP RRUSPD HVHQ WFSUHGLVSRVWD FRQ DOWUL VFRSL FRHOORLFOLWWHO HOOMHQOWFFHUWH]]D&XQFHUWDLQWLHVLQ ZLQG VSHHG VLGLQWGHHOOODD OG RLWWFD UEWRJLTRXODHG WDWGLPLVXUD FKH VL FRPPHWWRQR XWLOED DOORD WOODD GYLWVDHJLORVORHUED ODHPFDVR LQ HVDPH /¶LQFHUWH]]D q ULIHULELOH SULQFLSDOPHQWH

- x \$000 WDUDWXUD GHOO DQHPRPHWUR VSWHUPDE WOVDU IF DE XIMW YH GELDSWDELW [DQFKH WDEHOOD GEDHFJDDOWLEEUDDHJDRUQHRSODHUW GL LQVWDOOD]L
- X \$OOH FDUDWWHULVWLFKH RSHUDWLYH PERHEOHOO**OR**HRRWPENWJUNRWRQ FDXWHODWLYDPHQWH 9HO 9HQWR

x \$00D GLVWRUVLRQH GHO IOXVVR (GARHYOXOM) DODHJRORLPHHIWHUWRWLWGLLPLDDRWQ

- · ·
- X \$OOD GLVWRUVLRQHDGDHVOHDOUXHOUR GVRWYDXPVHDDQVVDHFDXWHODWL
- x \$ O V L V W H P D G L D FSTHXUL VOLDIL RY QL GI ROF ID W JLD GWHDO FYDHX QWWHRO D WWW YL D P H Q W H
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& RPH VL SXZ GHGXUUH GD TXDQWR VR & UYDDUOL PLEOLFOHHUW (201]] IX QY KRY YHORFLW J GHO YHQWR H FRPS CHHG VR LGYHDODHH OY WQHJROFIRLFQ JF YDULDUH GD FLUFD ILQR DQFKH DG ODROF XF (21 SRS XLOQWILWSRH (02 FHIXODWD X B) DY YDOXWD]LRQH GHOOD SURGX]LRQH DWY (0X HHUV DDOOP H CX VQ IB RWSXHUUEDL CQCDD H RDOLFHTXR DQFKH VXOODOERD JV HHDIGLEDOEBD WE WARRHUHDU MAR SHU GORO OHHV V DHOUWIL XQ ¶LQFHUW H]]D FRPSOHV V LYD GHO GHOFKIM V SERLYDUUDHQ CDROOHHV V DHOUWIL FRQVLGHUD]LRQHQOHGOHOONDD SOX RW (50 X) ILRRQH DWW HV D

6HGL RSHUDWLYH 9LD 0DWWHRWWL 7HO ±)D[

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1HOO¶DPELWR GHO SURFHVVR GL SUR HH SMLWYDL QL RJOHQ HGULDXOOH LOPHSOLOD VYLOXSSR GHO VLWR q QHFHVVDULR FOR LQWR JV FOHDU HT RFQRVOL VXWQHDQ JEDX RGOHDD OD GLVSRQLELOH H TXLQ ISS JL RGOHD ODDW W M DVD SMLBRL & DQ LJODRUOD HQHW LULOHYD JLRQL JUDQ GH]]H GL YHORFLW J H GL GLUH JLLR QL BIFOX HQ QL DVB QQ W R ÊS BIBV VXVQ ESLHOUHLI YDOXWD JLRQH XWLOH GHOOD ULVRUR DD WHLR OF B FQD GJDLWO JL LG LD V FWDDO JER QL FRQ VLG HUDWH VWRULFKH SHUFKP FROD OX QQLSHH URLORVGURHG LI HUOL OF HD W DR JLVRS QH H LQ IDWWL GLVSRUUH ROWUH DOOD QH BIUW HI UGJIL WS BD WWLR G LD QF BR HH VOLL UXDOF DF FKH SHU FRQ ID RQ WL H FRUUHOD JLRQ LP HVOR BQ WRL PULL VIXHOUW BW HG LD SYSHDQUWWRH HVWHVD FKH LQ FOXGH LO VLWR GL LQ WHUHVVH

/¶DQDOLVL H O¶HODERUD]LRQH GHLQGLDDWWLRGSHDOUOWDLFRWODDJURLQFHDQROCIDVH GL YDOLGD]LLROQLWYjOGDHGGLGSDRWORLEW XUOVOXIQQWW WIDREXSRQDRGR H GLVFPLVXUD]LRQH XWLOL]]DWR QRQ DYHQGRHULRVFRXQXVODUVDWW RL PVD⊗IOX QO]DFSHULRGR

, ULVXOWDWL GHOOH DWWLYLWJ GGDHOOO DG DYMD PO LOG DR JOLNR ODHP SO LODDFDH EQ KO SUHVHQWH VWXGLR HG LQGLFDQR FKHQLUOH YILL RWHR CqLLYQHWQHWULH VWDLYSURF NG DSSDUWHQHQ]D VRSUDWWXWWR LQOUOHDO DY HLORDQ HODXOLOG DP HQHUJLD VSHFL

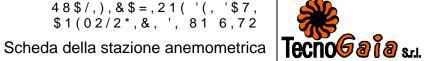
\$QFKHO¶DWWLYLWjGLYDOXWD]LRRQHQOWDDWHYORWORWDLWFRGSLSODR GLVSRQLELOLWjWRWDOHGHJOLDQGOPHOQHWOLSGXHOOWORHGYLHOPRLFIXWJDPGHLG FROVLGHUDWR

3 R V L W L Y D q U L V X O W D W D D Q F K H O DWYDH G L I Y FH DQ WG RY YO LOWD j FV RX CS GH LU] LL RR P G D O V X R O R

6L SXZ TXLQGL DIIHUPDUH FKH L ULVIAQWIRWILWGH 9 18 UH PRQXUO HLRD LQFHUWH]]H GL PLVIXOUODH SOUSHSSOUULHFFOXLDFWXIIU HIR XQVXLOZIMJ IDD DIWWHH RSSRUWX FDXWHODWLYDPHQWH VWLPDWH LQGIVISIRQIR EFLIOHH QU¶LHIQQWILWD J WG UHD OTDX HU OD UHDOL]]D]LRQH GL XQ LPSLDQWR HROLFR



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&RKSUQDWH GHO 5HWLFROR 870 Qf	LQ PHWUL
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141 Leroy Road ÂVilliston, VT 05495 ÂJSA
Tel 802.316.4368 ÂFax 802.735.9106 Â ZZZ VRKZLQG FF

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

Certificate number: 19.US1.02175 Date of issue:November 20, 2019
Type: NRG 40C Anemometer Serial number: 179500328134
Manufacturer: NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Client: NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA

Anemometer received:November 13, 2019

ember 13, 2019 Anemometer calibrated: November 18, 2019

Calibrated by: RDS Procedure: MEASNET, IEC 6140012-1:2017 Annex F

Certificate prepared by: EJF Approved by: Calibration enginee FJF

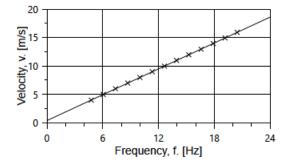
Calibration equation obtained: v [m/s] = 0.75949 f [Hz] + 0.36403

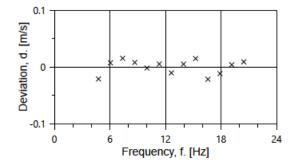
Standard uncertainty, slope: 0.00097 Standard uncertainty, offset: 0.02753 Covariance: -0.0000069(m/s)²/Hz Coefficient of correlation: U 0.999995

Absolute maximum deviation: -0.022m/s at12.941m/s

Barometric pressure: 999.1hPa Relative humidity: 19.7%

•					-		
Succession	Velocity	Temper	ature in	Wind	Frequency,	Deviation,	Uncertainty
	pressure, q.	wind tunnel	d.p. box	velocity, v.	f.	d.	u_c (k=2)
	[Pa]	[°C]	[°C]	[m/s]	[Hz]	[m/s]	[m/s]
2	9.24	22.3	28.0	3.963	4.7671	-0.021	0.023
4	14.54	22.4	28.0	4.972	6.0585	0.007	0.026
6	21.02	22.4	28.0	5.979	7.3736	0.015	0.030
8	28.58	22.4	28.0	6.973	8.6909	0.008	0.034
10	37.26	22.4	28.0	7.961	10.0058	-0.002	0.038
12	47.33	22.4	28.0	8.974	11.3294	0.005	0.042
13-last	58.25	22.4	28.0	9.955	12.6425	-0.011	0.047
11	70.65	22.4	28.0	10.964	13.9502	0.005	0.051
9	84.16	22.4	28.0	11.966	15.2572	0.015	0.055
7	98.43	22.4	28.0	12.941	16.5889	-0.022	0.059
5	114.24	22.4	28.0	13.942	17.8933	-0.012	0.064
3	130.82	22.3	28.0	14.919	19.1594	0.004	0.068
1-first	148.83	22.3	28.0	15.911	20.4591	0.009	0.072











EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor ६0017
2254	Control cup anemoeter
-	Mounting tube, D ╡2.7mm
TT004	Summit Electronics, 1XPT100, 100 Output wind tunneltemp.
TP001	PR Electronics 5102,-00V Output differential pressure botemp.
DP004	SetraModel 239, 01inWC, differential pressure transducer
HY004	Dwyer RHP2D20, 010V Output humidity transmitter
BP002	Setra M278, &VDC Output barometer
PL8	Pitot tube
XB002	Computer Board. 16it A/D data acquisition board
Njord1-PC	PC dedicated to data acquisition

7KH DFFXUDFLHV RI DOO PHDVXUHPHQWV ZHUH WUDFHDE @eathtim/We RanaWystkishhoodiyle Wwithfuld RXJK 1 the data acquisition software detects pulse frequency.



Photo of the wind tunneletup. The cross-sectional area i 2.5 mx 2.5 m

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA 4/02. The uncertainty at 10 m/s comply with the requirements in E6e6140012-1:2005 procedure. See Document US.12.01.004 or further details.

COMMENTS

(none)

Certificate number: 19.US1.02175



6FKHGD GL ,QWHUYHQWR 2SHU Q 14 02'4 0 \$ 1



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SPECIFICATIONS NRG #40C Anemometer

FEATURES

- x The standard anemometer used in the wind energy industry
- x Short distance constant
- x Simple, durable design

The NRG #40C anemometer is the industry standard anemometer used worldwide. NRG #40 anemometers have recorded wind speeds of 96 m/s (214 mph). Their low moment of inertia and unique bearings permit very rapid response to gusts and lulls. Because of their output linearity, these sensors are ideal for use with various data retrieval systems. A four pole magnet induces a sine wave voltage into a coil producing an output signal with a frequency proportional to wind speed. The #40C is constructed of rugged Lexan cups molded in one piece for repeatable performance. A protective rubber terminal boot is included.

SPECIFICATIONS

	Sensor type	3-cup anemometer
Description	Applications	wind resource assessmentx meteorological studiesx environmental monitoring
	Sensor range	1 m/s to 96 m/s (2.2 mph to 214 mph) (highest recorded)
	Instrument compatibility	all NRG loggers
	Signal type	low level AC sine wave, frequency linearly proportional to windspeed
	Transfer function	$m/s = (Hz \times 0.765) + 0.35$ [miles per hour = $(Hz \times 1.711) + 0.78$]
Output signal	Accuracy	within 0.1 m/s (0.2 mph) for the range 5 m/s to 25 m/s (11 mph to 55 mph)
	Calibration	each anemometer individually calibrated, calibration reports provided via electronic download
	Output signal range	0 Hz to 125 Hz (highest recorded)

SPECIFICATIONS

	Threshold	0.78 m/s (1.75 miles per hour)								
Response	Distance constant (63% recovery)	3.0 m (10 feet)								
characteristics	Moment of inertia	68 x 10 ⁻⁶ S-ft ²								
	Swept diameter of rotor	190 mm (7.5 inches)								
Installation	Mounting	onto a 13 mm (0.5 inch) diameter mast with cotter pin and set screw								
Installation	Tools required	0.25 inch nut driver, petroleum jelly, electrical tape								
Environmental	Operating temperature range	-55 °C to 60 °C (-67 °F to 140 °F)								
	Operating humidity range	0 to 100% RH								
	Connections	4-40 brass hex nut/post terminals								
Physical	Weight	0.14 kg (0.3 pounds)								
,	Dimensions	3 cups of conical cross-section, 51 mm (2 inches) dia. x 81 mm (3.2 inches) overall assembly height								
	Cups	one piece injection-molded black polycarbonate								
	Body	housing is black ABS plastic								
	Shaft	beryllium copper, fully hardened								
	Bearing	modified Teflon, self-lubricating								
Materials	Magnet	Indox 1, 25 mm (1 inch) diameter, 13 mm (0.5 inch) long, 4 poles								
	Coil	single coil, bobbin wound, 4100 turns of #40 wire, shielded for ESD protection								
	Boot	protective PVC sensor terminal boot included								
	Terminals	brass								

SPECIFICATIONS

NRG #200P Wind Direction Vane

FEATURES

- The standard wind direction vane used in the wind energy industry
- € Simple, durable design
- € Corrosionresistant materials

The NRG #200P wind direction vane is the industry standard wind direction vane used worldwide. The thermoplastic and stainless steel components resist corrosion and contribute to a high strength-to-weight ratio. The vane is directly connected to a precision conductive plastic potentiometer located in the main body. An analog voltage output directly proportional to the wind direction is produced when a constant DC excitation voltage is applied to the potentiometer. A rubber terminal boot is included.

SPECIFICATIONS

	Sensor type	continuous rotation potentiometric wind direction vane
Description	Applications	€ wind resource assessment € meteorological studies € environmental monitoring
	Sensor range	360° mechanical, continuous rotation
	Instrument compatibility	all NRG loggers
	Signal type	Analog DC voltage from conductive plastic potentiometer, 10K ohms
Outrout along al	Transfer function	Output signal is a ratiometric voltage
Output signal	Accuracy	potentiometer linearity within 1%
	Dead band	8° Maximum, 4° Typical
	Output signal range	0 V to excitation voltage (excluding deadband)
Power requirements	Supply voltage	Regulated potentiometer excitation of 1 V to 15 V DC
Response characteristics	Threshold	1 m/s (2.2 miles per hour)
Installation	Mounting	onto a 13 mm (0.5 inch) diameter mast with cotter pin and set screw
	Tools required	0.25 inch nut driver, petroleum jelly, electrical tape
Environmental	Operating temperature range	-55 °C to 60 °C (-67 °F to 140 °F)

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SPECIFICATIONS

	Operating humidity range	0 to 100% RH
	Lifespan	50 million revolutions (2-6 years normal operation)
	Connections	4-40 brass hex nut/post terminals
Physical	Weight	0.14 kg (0.3 pounds)
i nyoloai	Dimensions	€ 21 cm (8.3 inches) length x 12 cm (4.3 inches) height € 27 cm (10.5 inches) swept diameter
	Body	black UV stabilized static-dissipating plastic
	Shaft	stainless steel
Materials	Bearing	stainless steel
Materials	Wing	black UV stabilized injection molded plastic
	Boot	protective PVC sensor terminal boot included
	Terminals	brass

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NOMAD™ 2 WIND DATA LOGGER SPECIFICATIONS

SENSOR IN	NPUTS	USER INTE	ERFACE
12 counter inputs	Configurable for AC & pulse anemometers, other frequency- output devices, and high/low digital or relay state signaling	Local Display:	4 x 20 alphanumeric character display, LCD or VFD Configurable smart-switched power Automotic temporative componential LCD contract
	 Frequency range DC to 2 kHz High display resolution with low frequency anemometers 	Keypad	Automatic temperature-compensating LCD contrast 7-key sealed membrane keypad
	 Input high/low threshold configurable for 0V or 3V Configurable filtering for low frequency devices 1-second count integration, ±0.02% accuracy 	Remote interface	Full display, configuration, data transfer, & firmware upgradability by local port or modem connection to any PC via NOMAD Desktop™
8 analog inputs	Configurable range of 0 to 2.5V or 5V12-bit analog to digital conversion	Status light:	Heartbeat LED indicates operational status independent of display
	 1-second sampling, ±0.02% accuracy Direct interface to potentiometer wind vanes, 10k thermistors, and analog-output transducers 	INPUT ANI Wind speed	D DATA PROCESSING • Slope & offset scaling, auto-zeroing for counter inputs
Fault detection	Feedback input from 2.5V+ excitation output for wiring and device fault detection	Wind direction	Modulo 360° and true vector processing Deadband location correction
Internal temperature	e • 1-second sampling, ±2 ^a C accuracy	Temperature	Thermistor linearization to device accuracy (±0.1°C)
Power supplies	Measurement of two 9V batteries and 12V power	Math functions	Average, standard deviation, maximum, time of maximum, minimum, time of minimum, total, cycles, sample value
OUTPUTS 2.5V+ excitation:	2.5V+ smart-switched excitation distributed to all input	Recording intervals	1 minute, 10 minutes, hourly, or daily in any combination for all inputs and math functions
	terminal blocks for energy-conserving measurement of potentiometers and thermistors	DATA STO	RAGE
12V transducer power	Calibrated to ±5mV, 25 ppm/°C, 250 mA max 12V+ smart-switched transducer power output distributed to all input terminal blocks for energy-conserving operation of electronic transducers	Media	 Industry/consumer standard Compact Flash, up to 256MB Read/write-able by any notebook or desktop PC via PCMCIA adapter or any USB-type Compact Flash adapter Full -40° to 85°C operation rated devices available
12V modem power	 1 Amp maximum 12V+ configurable switched modem power output for energy-conserving operation of cellular & other modems 1 Amp maximum For de-icing or other control applications SPST dry contact, 1 Amp maximum, AC or DC 	Formats	Card directory & file formats are fully Windows™ compatible Any FAT (PC) formatted Compact Flash card fully usable Data written to daily files in named monthly subdirectories Each datum in standard IEEE floating point format, indexed for positive database ID independent of file name/location Each datum time-stamped in Universal Time (UT/GMT),
	Modbus-controlled	Transfer	configurable for time zone & daylight savings offsets Files transferable by card removal, local serial connection,
POWER SU			remote dial-up connection, or as e-mail attachments
9 Volt batteries:	 2 parallel standard 9V batteries in sliding receptacles Up to 6 months operation with alkaline, up to one year with lithium (-40°C) batteries that have no shipping restrictions 	PHYSICAL Operating temp:	-40° to 85°C all specifications (Vacuum Fluorescent Display)
12 Volt Power:	12V (10-18V DC) input for internal primary or rechargeable batteries, external DC power supply, or regulated solar panel Two-screw removable internal mounting for lead-acid batteries	LCD temperature: Internal RT clock	 LCD operates from -20° to 70°C, storage -30° to 80°C ±1 minute/month accuracy, internet time-server adjustable Backed up by socketed 2032 Lithium coin cell (10 year life)
	for higher power transducer, controls, and communication gear, standard sizes up to 20 AH, extreme environment sizes up to 8 AH	Wire & cabling	12 six-screw, 0.2" (5mm) cage clamp style terminal blocks Signal, ground, excitation, switched & unswitched 12V power distributed to each of 8 terminal blocks
Solar:	Optional on-board solar charging regulator/controller		Standard SMA-F bulkhead connector for external antennas Four 3/4" npt/pg21 knockouts for cable & conduit installation
SERIAL PC		Enclosure	Integrated waterproof instrument enclosure, wire and cable
Local port	3 independent RS232C serial ports, up to 115 kBaud Direct straight-cable connection to laptop or PC		junction box, and lockable rain shed • Upper section NEMA4/IP66 (watertight), lower section NEMA2P (rain tight) or NEMA4 with cable glands.
Remote port	Standard pinout DB9, DCE Connects to modem, radio, or asynch network adapter		 NEMA3R (rain tight) or NEMA4 with cable glands 16 ga. steel, 14 ga. mounting flanges, TGIC powdercoated 14 x 12 x 5.5 inches (350 x 300 x 140mm), 20 lbs. (9 kg)
Device Port:	 Auto-wakeup Rx input Internally connected for SWI-supplied modem options Field-wireable terminals for customer-installed devices Connects to and logs from communicating transducers including multifunction Phaser® power transducers & 		Mini-rack mounting for internal modem options Swing-out panels for modem and 12V battery access Surface, truss-tower, or tube-tower mounting Single no-tools padlockable hasp closure
	ultrasonic anemometers • Pollable Modbus RTU for SCADA and other general	AVAILABLE	OPTIONS
ESD PROT	applications ECTION		Vacuum Fluorescent Display GSM/GPRS, CDMA, and AMPS cellular modems Satellite modem (Iridium)
20011101	 All inputs, outputs, and serial port signaling transient and fault protected No additional lightning protection needed 		 Satellite modem (Iridium) Landline telephone (POTS) modem Integrated solar charging systems, including charge regulator, panel, mounting brackets, and lead-acid batteries

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FR QQRDQ YHORFLWj PHGLD FXELFD QHO PHVH LQ P

FR QDRDQ YHORFLW; PDVVLPD QHO PHVH LQ P V

FR QQRDQ SRWHQ]D VSHFLILFD PHGLDHGLHQDODP YHQD IOXLGD

FR OD RDQ HQHUJLD VSHFLILFD PHGLDKGPHO YHQWR QHO PHVI

'DLGDWL PHGL PHQVLOL VRQR SRL FDOOLFR&GHDWOH LVWHDVOVRHULJUPD FRORQQD H TXLQGL L YDORUL PHGLOWRRUWLD1001W IDFQDQQXBOOL S4DXUH YHORFLW J GHO YHQWR PHGLR DQQXDOH QEQQQRVLORWVDWYLHRV LQGLSHQGHQWHPHQWH GDOOD QXPHWBVPLHWjLGGHHLOGDTYWQODRFTXI O FDOFROR DVVXPH VLJQLILFDWR VROR VH SHU RJQL PHVH DFTXLVLWL 0HT PDJJLRUH GL DOPHQR LO

*5\$),&2 5 L S R U W D J O L D Q G D P H Q W L G H O O D Y HHĐ OR LFTDL W j PI D VGVHL PĐ DO R G HM TXDGUDWLFR PHGLR GHOOD YHORFLWQLGH/ODQHRQWR JQLHUQROGH VHWWRULGL f FLDG/HFXLQOR 1 & O O DHQJ/RLO &

FRQVLGHUDUH SRVLWLYR LO VHQVRfGFLRWRJWVD\$JRRQQGHH FOU DWWLRH

± 6 & \$ /*\$D BJ GER.QQHW 9 D GE 7 U R P S L D % 6 9LD 0DWWHRWWL ±)D[

9LD 0DWWHRWWLDUGRQH 9DO 7URPSLD %6

 $\begin{array}{ccc} & \&\,R\,G &)\,L\,V\,F \\ \&\,D\,S & 6\,R\,F & 1\!\!/4 \end{array}$,9\$ LQWHUDPHQWH YI VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFL





- *5\$),&2 ,QGLFD OD GLVWULEX]LRQH GHOO HGODHUOLDN:KQSHHOFOLHILEGD.YGHHUO GLUH]LRQL / DQJROR JLUR q VWDWR FVLXOGVGFLXYQLRVR\$DOD DQVR FRUULVSRQGH LO 11RLUGGHHUDVLHGSHR/VHL16VRROWRD]LLOROVHHORVURDLGLLR DOO FRUULVSRQGH O (VW HFF
 - ,O JUDILFR WLHQH FRQWR SHU FLDVFFDQCIBHGOLUHHLORWOMR VFLKOHGLQWHQVLWj HVVR LQIDWWL HYLGHQQLWDR LFRVQHWPWDRJULRUGLFRGQUHQHUJHWLFR
- *5\$),&2 5LSRUWD O¶LVWRJUDPPD GHOOH YHOURWFLEWTJXPDDGWWDLWFLHFRPHPGHGI YHORFLWJ QHL PHVL GHOO DQQR
- *5\$),&2 5LSRUWD PHVH SHU PHVH O DQGDPHQWRFGHDQOHDQMHQDDIQ N:K P ,O JUDILFR PHWWH LQ HYLGHQ]D OH FRPSRQHQWL VWD
- *5\$),&2 5LSRUWD JOL DQGDLPWHjQPWDLV CGIHPODO DPM HSDOLDSWFRR CGM DDGORDWFLFR PHO YHORFLW j QHOO DUFR GHOOH RUHGGHO PILLORXVOQR GSHHOUDDR JJQL ULSRUWDWD OD PHGLD GHL YDORUL ODHOJD VQWQORDWOLHOODHLQ FRUULVSRQGHQWH
- *5\$),&2

 5LSRUWD O LVWRJUDPPD GHOOD SRWOHXQLJODV SOLFILOPO FODUFR GOLIÐ RUH GHO JLRUQR SHU RJQL LQWHUYDOOR GL PLQXWL O SRWHQ]H ULOHYDWH QHL GLYHUVLF BRLURULLOY IS ROOHOO DWOHQRO QJHO LQ HYLGHQ]D OD FROPOSLRHOUHDQOWHHO JOLDRUUQVRUVD HROLFD
- 7\$%(//\$' 6RQR ULSRUWDWL SDUDPHWUL VWLD YS'HLVUWOLFFLWOXHUGE HEN YON'H YOU LINDOUW GHILQLWD FRPH UDSSRUWR SHUFHQWOXGO YO DODHWYLF RO PER PER GYLDROG HEND COOPER UULPVLSQRXOWG GLUHRQWH YDORUH PH

7 ~ VLJ9 9PHG

,OYDORUH GLWXUEROHQ]DYLHQHFQIBIEROBIWGRXWROWRXSHULYEPVLQWDWLVFLULGEBIOYODV NYSODUU VHWWRULGLGLUH]GBQYHHOPIRSFHLWY jFOROQVRS/DUULWS/BBRWODDWULHV

FROORDQ VHWWRUH GL GLUH]LRQH R FODVVH GL YHORFLWj

FROQROQ SHUFHQWXDOH GL RFFRUDNG]H QHO VHWWRUH R

FR @ RDQ QXPHUR GLQ ROF IFF Θ UVUHHVQVI/HRUH R QHOOD FODVVH

FROORDQ WXUERO #1/PO/H/DG V/BIWWRUH R QHOOD FODVVH

FROORDQ VFDUWR TXDGUDWLFR V7ZHY6QLHRO GMHOWOVDRWUM URE RQOHOOD DID

HGL RSHUDWLYH
9LD 0DWWHRWWL ± 6&\$/*\$D8JQ=R,QQHW9DQ=7URPSLD %6
7HO ±)D[

6HGH /HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFL





> FROQROQ YDORUH SHU7F2HQWQLHOOHVDHOWWRUH R QHOOD FODVVH XQ YDORUH PLQLPR GL WXUEROHQ]D FWKjHGdHOXSHUDW

FROQROQ YDORUH SHUFH7OFWLORQHDDOVHWWRUH R YQYHROOD FUDSSUHVHQWD XQ YDORUH PDVXYQLDPR GSUREDELOLWJGHO

/D SULPD ULJD 7RWDOH UDSSUHVHQWD L SDUDPHWUL GHOOD YHORFLW; GHO YHQWR VXSHULRUL DOW O'BD CORDUN'HOFIR (GOD PUDL GOD FRQWUDVVHJQDWD DG ID SDWDD \$P\$HUWHUMH (QQMHO GOBO COLDV WW UX LUEEXR) O RIQ]D YHORFLW; GHO YHQWR VXSHULRUL D P V

, Q TXHVWR 7RWDOH QRQ YHQJRQR TXHLQBSELFWR, QPVLLQGRHUULD VQH TXHOOH LQ FXL O¶DHURJHQHUDWRUH VQRQQRSUURLGSXRFHIWHD WSHU GHOOD GLVWULEX JOLFROQFIK OGHDDOODODUW KEEDHEHROODOGHDLHQUWRHJUHOQWHUDDUWRUH

*5\$),&2 5LSRUWD O LVWRJUDPPD GHOOD GLVRWOUHLOZEJENGLHRQLHODGHÖOGIQDRV YHQWR QHOO LQWHUYDOOR GL GLHFGLLPGLENGUXDWWLDHVOSDHUFIRRUHUQLWISS 1HO JUDILFR VRQR ULSRUWDWFIKHDODDVSUSUHHVOHAQHWD GLVWULEX]LRQH GL IUHTXHQ]D H ODXUFEXRUOYHDQGDD GDXODD NGWDD NGWLL YHORFLW; GHO YHQWR VXSHULRUL NDDHDIRWJHDOXHHODOWHROJELLQWH

7\$%(//\$ (6RQR ULSRUWDWILV SWIDLUFD PUHHWOUDLW YL WILD SIGNHLU YLDOORUDIS SRRWWWHRQ 660 MUD U I YHORFLW j GHO YHQWR GHILQLWR FRPHGUHD SDSDR VI WY ORRUW D JLOOH ULOHYDWR QHL PLQXWL HG LO FRUULV SRQGHQWH YDORUH 5 PD [9 9PHG

> ,O YDORUH GHO UDSSRUWR GL UDIILFFDL WYLHOPH GFDLOHFRODD WR VXSHULRUL D PV LQ WDEHOOD WLSODESULOVFRHQWRUEOVOWD WILF VHSDUDWDPHQWH SHU VHWWRUL GL GQLUSHDIURWQLFRHOBHH FQQRV

FROONDO VHWWRUH GL GLUH]LRQH R FODVVH GL YHORFLWj

FROORDQ SHUFHQWXDOHGL RFFRUDNG|H QHO VHWWRUH R

FROOMBOQ QXPHUR GLQROEHFOUWUHWQWHRUH R QHOOD FODVVH

FROORDQ UDSSRUWR GALPHYDOQIHLODVPHMVGYLRRUH R QHOOD FODVVH

FROQROQ VFDUWR TXDGUDWLFR PHGL/RL/GOQHHOO UVDHSWSWYURWIR BSL FODVVH

FROQRDQ YDORUH SHUSFEHQWQLHOOHVDHOWWRUH R QHOOD FODVVH XQ YDORUH PLQLPR GHO UDSSRUWR GLSUBEIDLEDOFLKWH GHO

HGL RSHOUWLYH 9LD 0DWWHRWWL ± 6&\$/*\$DBIGER,QQHW9DGE7URPSLD %6 7HO ±)D[

6HGH /HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

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,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFL





FROQROQ YDORUH SHUFH5OFWLORQHDOOVHWWRUH R QHOOD FUDSSUHVHQWD XQ YDORUH PDVVLPR GHODUWDFSSFRRUQW XQD SUREDELOLWj GHO

/D SULPD ULJD 7RWDOH UDSSUHVHHQ GWHDOLU BSSLIPDUPWHRW CGL CGE WXWWH OH YHORFLW GHO YHQWR VXPSHYULPRHUQ WD LODHYD DODR WHFG 7RWDOH FRQWUDVVHJQDWD GD WULL DXSJSL BICHWHG CHWO DUDLSSUDILFD VROR SHU YHORFLW GHO YHQWR VXSHULRUL D PV, QTXHVWR 7RWDOH QRQ YHQJRQR TXHLQ BELFWR, QPVLLQCRHUULD WGH TXHOOH LQ FXL O¶DHURJHQHUDWRUH VQRQ RSUURLGSXF HWHD WSHU GHOOD GLVWULEX] LGRQUHD GIHL DDU DENSHSRDHQWARWW EDEUHH DOO¶DL LQ LWRJHQHU

- *5\$),&2 5LSRUWD OLVWRJULEINFPLDROGHHOEOHDOGULDMSMSURGUHWONFODGLYHUODRIFLFW JGHQHOOLQWHUYDOORGLGLHFLPLQXWLHOD FRUULVSRQGHQW
 1HO JUDILFR VRQR ULSRUWDWFIKHDODMSUSUHHWOHXQWDD
 GLVWULEX]LRQHGLIUHTXHQ]DHODDSFSXRUYWORGGLGWDDWFDDGFHDLCOHVONKHGUHWOHYQHUDWR
- 7\$%(//\$ * 6RQR ULSRUWDWL SDUDPHWUL VWBDWUWWYLFKDUGHUODDWLFRLPDHUGLODHYJFJXQURDSSHUHVHRCGLUHJLRQH GHO YHQWR PLVXUDWL SHUDFQLODHYJFJXQURDSSHUHVHRCWXUEROHQJD GHOOD GLUHJLRQH GHO YHQWR, O YDORUH GHOOR VFDUWR TXDGUDWLFR PHGLR GYHLBIQDB GLFRQVLGHUDWR VROR SHU YHORFLWJ PHRSLVH QQLWDEPHLQQXDVLL VSVWDWLVWLFL GHVOROQDR YFDOUDLVDWELUQFIDWL VHSDUDWDPHQWH SHU

FODVVLGLYHWOIRFROWDU,HQVSRDQURULSRUWDWL

FROONDO VHWWRUH GL GLUH]LRQH R FODVVH GL YHORFLWj

FROONDO SHUFHQWXDOH GL RFFRUDNG H QHO VHWWRUH R

FROOMBOQ QXPHUR GLQROEHFOLUWUHWQWHRUH R QHOOD FODVVH

FROQRDQ PHGLD GHOOD YDULDPELLCOOHHYOFD HIW WY ROLLHU HR] LORHOOHOD

FROQROQ VFDUWR TXDGUDWLFR PHGULFR]LGRHAQQHOQ HAYOO UVLBI EVLWORI I QHOOD FODVVH

FROQRDQ YDORUH SHU'B'HQWQLHOOHVDHOWWRUH R QHOOD FODVVH
XQ YDORUH PLQLPR GL VFDUWR GHOOD QLDUH]LRO
SUREDELOLW; GHO

FROQRDQ YDORUH SHUFH'69, WLOHQHDDOVHWWRUH RHOYH'69, OD FUDSSUHVHQWD XQ YDORUH PDVVLPRXOSHUWDFWDRUWFRRQOXQD SUREDELOLW; GHO

9LD 0DWWHRWWL 7HO ±)D[

 \pm 6 & \$ /*\$D BJ G±R,0QHW 9 D G± 7 U R P S L D % 6

6HGH /HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YF
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFL





PHGLR GHOOD GLUH]LRQH SHU WXWDWOHYODHO RYUHHO RSELEWD OOPHDOG PHQWUH OD VHFRQGD ULJD 7RWDOH FBQLW USDDWJOHPJODWLD GO GLVWULEX]LRQH GHOOD YDULDELO H GWHFOD UYWM RQ WGRLUWHX]SER LOW LIBRUR WRC Q TXHVWR 7RWDOH QRQ YHQJRQR TXHLQBELEWB, QPVLLOGRHUULD WGH TXHOOH LQ FXL O¶DHURJHQHUDWRUH VQRQ RS ULRLGSXFE H WHD WS HU GHOOD GLVWULEX]LRQH GHOOR VFDQJMW RWTXXLDEGRUODHWQLJ ERGPHHOGOLDR FKH DQGUHEEH DG LQWHUHVVDUH O¶DHURJHQHUDWRUH

*5\$),&2 5LSRUWD O LVWRJ**W.B.R.**PLDROGHHOGOHDOOGR.VRWFUBHIOWLRRTOXHOOGOID WGLLFUH]I
YHQWR R WXUEROHQ]D QQHHOOOODQOWLHUHY]DLROQR GL GLHFL PLQX
FXUYD GL GXUDWD VSHULPHQWDOH

1 HO JUDILFR VRQR ULSRUWDWFIKHDODOWSUSUHHVOHXQWDGLVWULEX]LRQHGLIUHTXHQ]DHODFXUYDGLGXUDWDGHLVROHYHOOOWHROGH

7\$%(//\$ + 6 R Q R U L S R U W D W L L S D U D P HGW UWLH P SI HWU ID WW XLUVD WULL K FLDVFXQR G H L P H V L G H O O ¶ D Q Q R , Q S D U W L F R O D U H V R Q R U L

FROORDQ QRPH GHO PHVH

FROQROQ QXPHUR GL PHVL HTXLYDOBQWULDSSRDUFWTFXLWUJDLRLOO WRWDOH GL GDWL DFTXLVLWL HQWUR TXHO PHVH D WRWDOH GL GDWL DWWHVL QHO SHULRGR GL TXHO

FROORDQ QXPHUR GL ULOLHYL UHJLVWUDWL

FROORDQ WHPSHUD*MPXLUQ*DQP£QQLPD

FROORDQ WHPSHUD7WPXHUGDQPH8GLD

FROORDQ WHPSHUDWIRADI/Of &PDVVLPD

'DL GDWL PHGL PHQVLOL VRQR SRDOFQDXDFQDDGWHDOLHYDOOVRUVLHPH FROBQQ

*5\$),&, 5LSRUWWODLQBQGDPHQYSWELUGDHWOXOUDDWPHLPQLPD PDVVLPD H PHGLD GHOO¶DQQR H QHOO¶DUFR GHOOH RUH GHO JLRUQR

6HGH/HJDOH 9LD 0DWWHRWWLDUGREQH 9DO 7URPSLD %6

&RG)LVF 3 ,9\$

&DS 6RF ¼ LQWHUDPHQWH YH
,VFUL]LRQH QHO 5HJLVWUR ,PSUHVH %UHVFL

67\$ = ,21(\$1(020(75,\$\$5,)(5,0(172)LRQ9H %DVLOLFDWD \$RG 5,))3HULRGR GL HODERUD]LRQH JLRUQL QXPHUR 3HUFHQWXDOH GDWL GLVSRQLELOL GDWL V P GDO V 9HORFLWD GHO YHQWR 9 LQ P V ULOHYDWD D

7DEH\$OD&859\$ ', '85\$7\$ '(//\$ 9(/2&,7\$ '(/ 9(172

PV	RUH D	QQR	Р	V RU	H DQQR

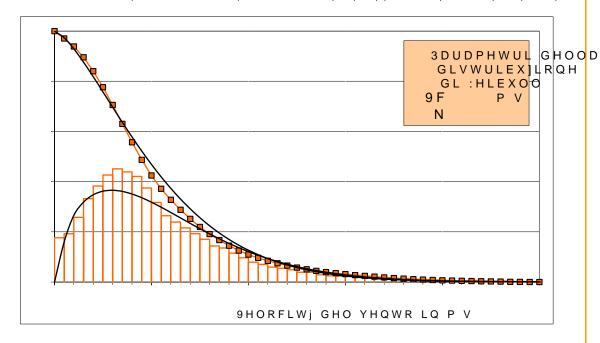
3DUDPHWUL GHOOD GLVWULEXJLRQH GL :HLEXOO 9 F

3 DUDPHWUL GHOODRYFHDOORFFFLONG WGLH FOR ROUGH CG NOW GHL VENKUOLOEX]LR VTP9 PV 9 F X E 3RWHQ]D VSHFLILFD GHOOBYYHQD:10PXLGD

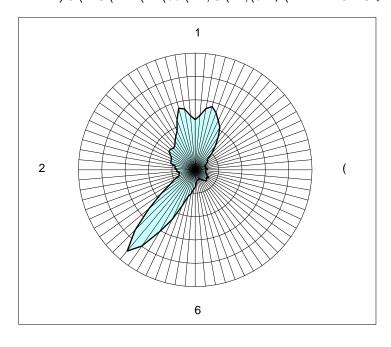
7 D E H \$ O D

67\$=,21(\$1(020(75,&\$ 5,)(5,0(172JLRQ5H %DVLOLFDWD &RG 5,) B JLRUQL 3HULRGR GL HODERUD]LRQH QXPHUR 3HUFHQWXDOH GDWL GLVSRQLELOL GDWL V 9HORFLWD GHO YHQWR 9 LQ P V ULOHYDWD D P GDO V

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* UDILFR) 5(48(1=('(//(',5(=,2/19('172 526\$ '(, 9(17,



67\$=,21(\$1(020(75,&\$ 5,)(5,0(172JLRQ5H %DVLOLFDWD & RG 5,) B 3HULRGR GL HODERUD]LRQH JLRUQL QXPHUR 3HUFHQWXDOH GDWL GLVSRQLELOL GDWL V 9HORFLWD GHO YHQWR 9 LQ P V ULOHYDWD D P GDO V

7 D E H O O D3 $\frac{5}{6}$ \$ 0 (75, '(//\$ 9 (/2 & ,9 \$17'2/3 (5 6 (7725, ', ',5 (=,2 1 (

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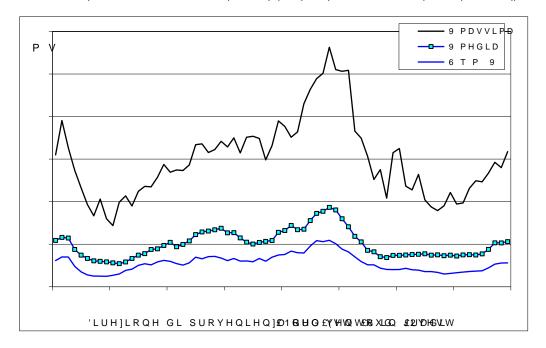
6 W D J L R Q H	9PHG PV	VLJ9 PV	9FXE PV	9 P D [P V	3 Y : P	(Y N:K P
,QYHUQR 'LF) H E					
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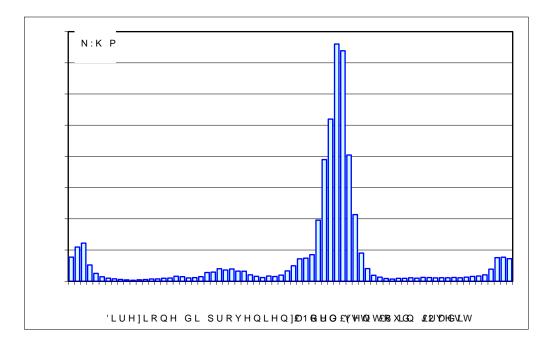
1RWD0HT 1XPHUR HTXPLHYVDLOFIRQOWHULGOLHYD]LRQH GL GDWL

67\$=,21(\$1(020(75,&\$ 5,)(5,0(172JLRQ5H %DVLOLFDWD &RG 5,) B < JL R U Q L 3HULRGR GL HODERUD]LRQH QXPHUR 3HUFHQWXDOH GDWL GLVSRQLELOL GDWL V 9HORFLWD GHO YHQWR 9 LQ P V ULOHYDWD D P GDO V

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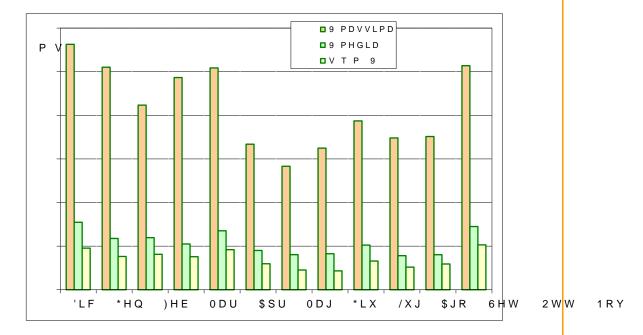


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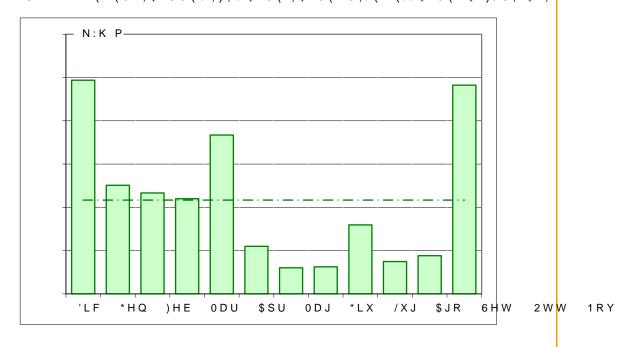


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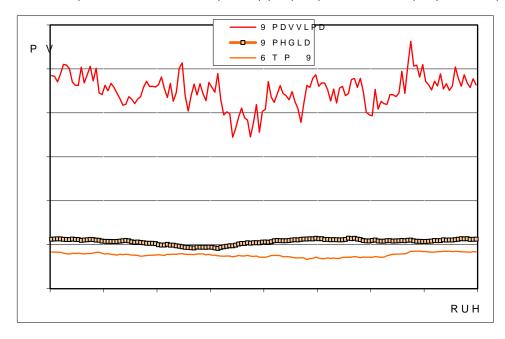


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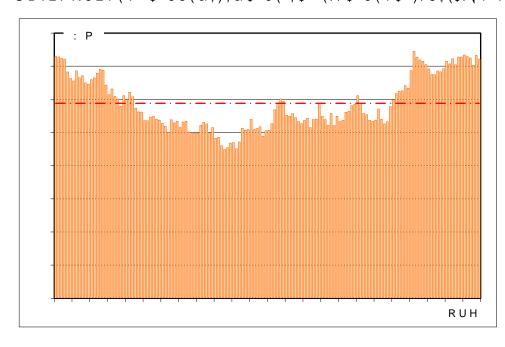


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*UDILFR327(1=\$ 63(&,),&\$ 0(',\$ '(//\$ 9(1\$)/81,\%/(1 : 2P5(



67\$=,21(\$1(020(75,&\$ 5,)(5,0(172)LRQ5H %DVLOLFDWD & RG 5,) B < 3HULRGR GL HODERUD]LRQH JLRUQL QXPHUR 3HUFHQWXDOH GDWL GLVSRQLELOL GDWL V. 9HORFLWD GHO YHQWR 9 LQ P V ULOHYDWD D P GDO V

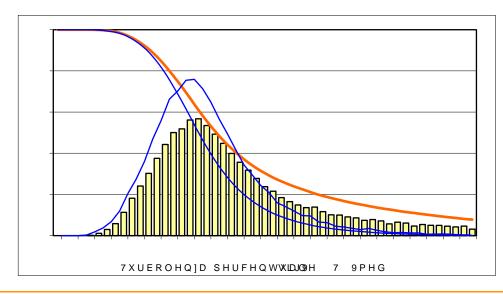
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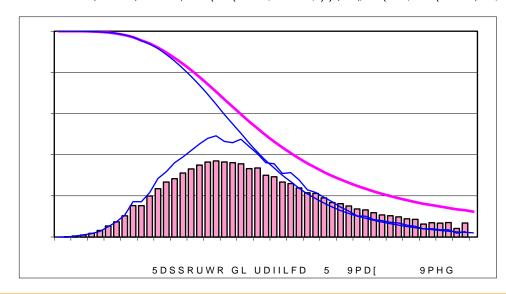
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