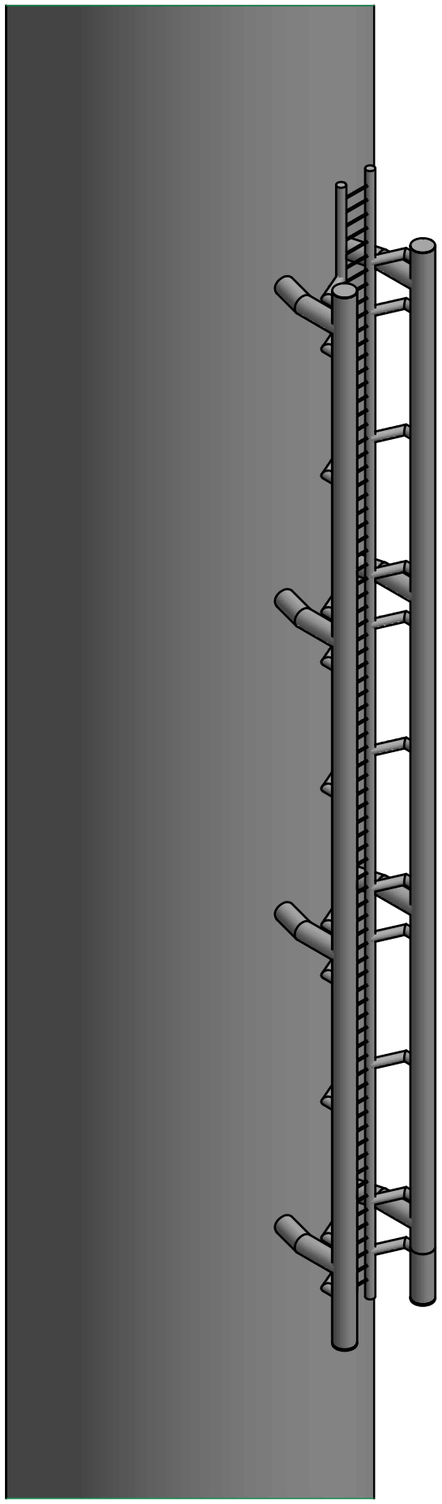
RECOMMENDED BOAT LANDING GEOMETRY FOR PUBLIC RELEASE

- THE AIM OF THE OWA PROGRAM IS TO REDUCE THE COST OF OFFSHORE WIND TO BE COMPETITIVE WITH CONVENTIONAL ENERGY GENERATION AS WELL AS TO PROVIDE INSIGHTS REGARDING INDUSTRY STANDARD (AND BEST PRACTICE) HEALTH AND SAFETY REQUIREMENTS.
- THE AIM OF THIS GENERIC BOAT LANDING GEOMETRY IS TO IMPROVE CONSISTENCY ACROSS NEW WIND FARM DEVELOPMENTS. ALL BOAT LANDINGS SHALL AIM TO BE ROBUST AND HAVE SUFFICIENT STRENGTH TO WITHSTAND, WITHOUT PERMANENT DAMAGE, THE EXPECTED OPERATIONAL LOADS THROUGHOUT ITS DESIGN LIFE. CONSISTENCY CAN HELP REDUCE OPERATIONAL COSTS AND MEANS PERSONNEL CAN GAIN FAMILIARITY WITH THE LAYOUT.
- THE BOAT LANDING WILL BE DESIGNED TO REDUCE THE IMPACT ON THE PRIMARY STEEL BY HAVING FATIGUE EFFICIENT CONNECTIONS AND ALSO A FAIL FIRST MECHANISM UNDER ABNORMAL LOADS.
- THE ASSESSMENT COMPLETED FOR THIS PROJECT AND THE CONCLUSIONS MADE ARE FOR A GENERIC BOAT LANDING DESIGN. THE PROJECT WAS COMPLETED ON A NUMBER OF ASSUMPTIONS TO ENABLE DESIGN INPUT PARAMETERS TO BE DEFINED. FOR A SPECIFIC PROJECT THESE ASSUMPTIONS SHOULD BE CHECKED AND VALIDATED AGAINST AVAILABLE DATA TO ENSURE THEY ARE APPROPRIATE. THESE DRAWINGS ARE FOR A GENERIC DESIGN CASE AND NOT INTENDED TO REPLACE A DETAILED BOAT LANDING DESIGN ASSESSMENT AND REVIEW PROCESS.



ISOMETRIC VIEW RECOMMENDED BOAT LANDING DESIGN

KEY ASSESSMENT PARAMETERS

IMPACT FORCE

THE OPERATIONAL AND ABNORMAL DESIGN CTV IMPACT FORCES ONTO BOAT LANDING SHOULD BE CALCULATED USING THE METHODOLOGY IN DNVGL-ST-0437 [7]. THE FOLLOWING COMPONENTS ARE RECOMMENDED TO BE ACCOUNTED FOR IN THE CALCULATION OF THE IMPACT FORCE:

- STIFFNESS & ACCEPTABLE DEFORMATION OF CTV FENDER
- EXPECTED MAXIMUM DISPLACEMENT OF CTV IN OPERATION AND ASSOCIATED ADDED MASS FACTOR
- DECELERATION OF CTV DURING VESSEL IMPACT NOTING ERGONOMIC SAFETY LIMITS FOR PERSONNEL
- DEFLECTIONS OF BOTH FOUNDATION (PRIMARY AND SECONDARY STRUCTURE) & CTV FENDER TO BE USED IN ENERGY BALANCE CALCULATION
- CONTRIBUTIONS FROM WAVE AND CURRENT TO VESSEL IMPACT SPEED

AN APPROACH ANGLE FOR IMPACT OF +/-45 DEGREES FROM THE CENTRELINE OF THE BOAT LANDING WAS REVIEWED AS PART OF THIS PROJECT

WORK ON IMPACT FORCE CALCULATION IS ONGOING AS PART OF OWA ACTIVITIES

CRUSHING FORCE

IF CTVs WITH A GRIPPER DOCKING SYSTEM (FOR EXAMPLE, A CLAMPING SYSTEM WITH ASSOCIATED MOTION COMPENSATING SYSTEM POSITIONED AT THE FRONT OF THE CTV WHICH CLAMPS TO A BUMPER BAR) ARE USED ACROSS THE WIND FARM; THE BUMPER BARS WILL NEED TO BE CHECKED FOR LOCAL BUCKLING AND FAILURE DUE TO THE CRUSHING FORCE FROM THE DOCKING CLAMP.

MATERIAL AND LOAD FACTORS SHOULD BE APPLIED ACCORDING TO RELEVANT CODE REQUIREMENTS.

BOAT BUMPER IMPACT ELEVATION INPUTS

AT THE HIGHEST TIDAL CONDITIONS DURING WHICH TRANSFERS ARE TO BE UNDERTAKEN, AND ALLOWING FOR VESSEL HEAVE DUE TO SEA STATE, THE VESSEL MUST NOT BE CAPABLE OF RIDING OVER THE TOP OF THE BUMPER BARS, AND ANY REST PLATFORMS ON THE LADDER MUST BE CLEAR OF THE VESSEL [6].

UPPER LIMIT ASSUMPTIONS AND VALUES:

- GLOBAL WATER LEVEL RISE = + 0.3m
- WATER DEPTH UNCERTAINTY = + 0.5m
- MAXIMUM VESSEL FREEBOARD = + 4.0m
- WAVE CREST HEIGHT @ Hs OF 2.5m = 2.5 * 1.86 * 0.6 = + 2.8m

TOTAL: HAT + 7.6m

AT THE LOWEST TIDAL CONDITIONS DURING WHICH TRANSFERS ARE TO BE UNDERTAKEN, AND ALLOWING FOR VESSEL HEAVE DUE TO SEA STATE, THE VESSEL MUST NOT BE AT RISK OF BECOMING TRAPPED BENEATH THE BUMPER BARS [6]

LOWER LIMIT ASSUMPTIONS AND VALUES:

- WATER DEPTH UNCERTAINTY = - 0.5m
- MINIMUM VESSEL FREEBOARD = + 0.5m
- WAVE TROUGH HEIGHT @ Hs OF 2.5m = 2.5 * 1.86 * 0.4 = - 1.9m

TOTAL: LAT - 1.9m

G+ GUIDELINES [6]

SAFE ZONE:

A SAFE ZONE TO PROTECT PERSONNEL FROM POTENTIAL CRUSHING, EXTENDING FROM THE LADDER FACE OF 500mm SHALL BE MAINTAINED AT ALL TIMES.

MAXIMUM STEPPING DISTANCE:

THE DISTANCE FROM THE LADDER TO A SAFE AND SUITABLE NON-SLIP WALKING SURFACE ON THE CTV SHALL BE A MAXIMUM OF 650mm FROM THE CENTRELINE OF THE LADDER RUNG TO ALLOW SAFE ACCESS.

A DISTANCE OF 850mm FROM THE FRONT OF THE BUMPER TO THE CENTRELINE OF THE LADDER RUNG IS RECOMMENDED AS THIS FULFILS THESE REQUIREMENTS. WHERE POSSIBLE 850mm SHOULD BE USED ACROSS DIFFERENT WIND FARM DEVELOPMENTS TO IMPROVE CONSISTENCY AND AID FAMILIARITY IN OPERATIONS.

THE 850mm BUMPER OFFSET IS MOST APPLICABLE IN AREAS OF NEW WIND FARM DEVELOPMENTS. WHERE PROJECTS ARE TO BE LOCATED CLOSE TO EXISTING WIND FARMS, THE LAYOUT OF THE EXISTING WIND FARMS SHOULD BE TAKEN INTO CONSIDERATION. IT IS NOTED THAT IN BOTH UK & EUROPEAN WATERS A BUMPER OFFSET DISTANCE OF 770mm IS COMMONLY USED AS PER RECOMMENDATIONS IN [5].

CORROSION ALLOWANCE

DUE TO MATERIAL LOSS THROUGH ABRASION AND IMPACT BY CTVs A CORROSION ALLOWANCE OF BETWEEN 2-4mm IS RECOMMENDED IN [8]. A CORROSION ALLOWANCE OF 4mm IS RECOMMENDED FOR THE BUMPER BAR SURFACES THAT ARE SUBJECT TO ABRASION FROM CTVs AND 2mm FOR OTHER SURFACES. THE REQUIRED CORROSION ALLOWANCE IN EACH PROJECT SHOULD BE REVIEWED ALONGSIDE THE PAINT/COATING SPECIFICATION AND THE CORROSION PROTECTION STRATEGY.

ALL MEMBERS SHALL AIM TO BE SEALED TO PREVENT INTERNAL CORROSION.

A THERMALLY SPRAYED COATING CAN BE APPLIED FOR ADDITIONAL CORROSION PROTECTION; THIS SHOULD BE REVIEWED ON A PROJECT SPECIFIC BASIS.

PROJECT DETAILS

AS PART OF THIS PROJECT OTHER AREAS OF THE BOAT LANDING DESIGN WERE REVIEWED. THESE ARE DETAILED IN [1] AND INCLUDE: CONNECTION DETAILS TO PRIMARY STRUCTURE INCLUDING FATIGUE IMPLICATIONS, SYMPATHETIC LOADING EFFECTS, FAIL FIRST DESIGN CRITERIA, AREAS OF DESIGN TO AID OFFSHORE REPLACEMENT OF BOAT LANDING IF DAMAGED, VORTEX INDUCED VIBRATION & SUPPORT ELEVATIONS.

REFERENCES

[1] MARKET REVIEW AND BOAT LANDING DESIGN BRIEF, REV A2, ATKINS, FEB 2019
[2] LOADS AND SITE CONDITIONS FOR WIND TURBINES, DNVGL-ST-0437, DNVGL, NOV 2016
[3] BS EN ISO 14122 PARTS 1 -4: SAFETY OF MACHINERY, JUNE 2016
[4] BS EN 50308 WIND TURBINES - PROTECTIVE MEASURES, DEC 2005
[5] STANDARDISED BOAT LANDING RESEARCH REPORT, IMCA SEL 041, M 232, SEPT 2016
[6] WORKING AT HEIGHT IN THE OFFSHORE WIND INDUSTRY, G+ GOOD PRACTICE GUIDELINES, NOV 2014
[7] LOADS AND SITE CONDITIONS FOR WIND TURBINES, DNVGL-ST-0437, DNVGL, NOV 2016
[8] SUPPORT STRUCTURES FOR WIND TURBINES, DNVGL-ST-0126, DNVGL, JULY 2018.

ACRONYMS

HAT = HIGHEST ASTRONOMICAL TIDE
LAT = LOWEST ASTRONOMICAL TIDE
OWA = OFFSHORE WIND ACCELERATOR
CTV = CREW TRANSFER VESSEL
WTG = WIND TURBINE GENERATOR

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

OTHER THAN THE HAZARDS/ RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NO FURTHER SIGNIFICANT RISKS HAVE BEEN IDENTIFIED

NOTES:

1. WORK IN ASSOCIATION WITH CARBON TRUST AND OFFSHORE WIND ACCELERATOR PROGRAM (OWA PARTNERS: EnBW, RWE RENEWABLES, INNOGY SE, ØRSTED, SCOTTISH POWER, RENEWABLES/IBERDROLA, SHELL, SSE RENEWABLES, EQUINOR, VATTENFALL WIND POWER).
2. LARGER VESSELS (>>120te) ARE IN OPERATION, FOR EXAMPLE, SATVs. THESE ARE CURRENTLY EXCEPTIONS AND SHOULD BE CONSIDERED ON A CASE BY CASE BASIS - SEE [1] FOR DETAILS.

REV	DATE	DESCRIPTION	BY	CHKD.	APPD.
02	09/12/2019	ISSUED FOR REVIEW	OA	OA	AD
01	04/09/2019	ISSUED FOR REVIEW	OL	WH	OA

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Client: CARBON TRUST + OWA PARTNERS

Project Title: CARBON TRUST - RECOMMENDED BOAT LANDING GEOMETRY

Drawing Title: PUBLIC RELEASE DRAWINGS

GENERAL NOTES AND DESIGN BRIEF SUMMARY

Scale	Package Code	Drawn	Checked	Authorised
		OL	WH	OA
Original Size	**Functional Area**	**Date**	**Date**	**Date**
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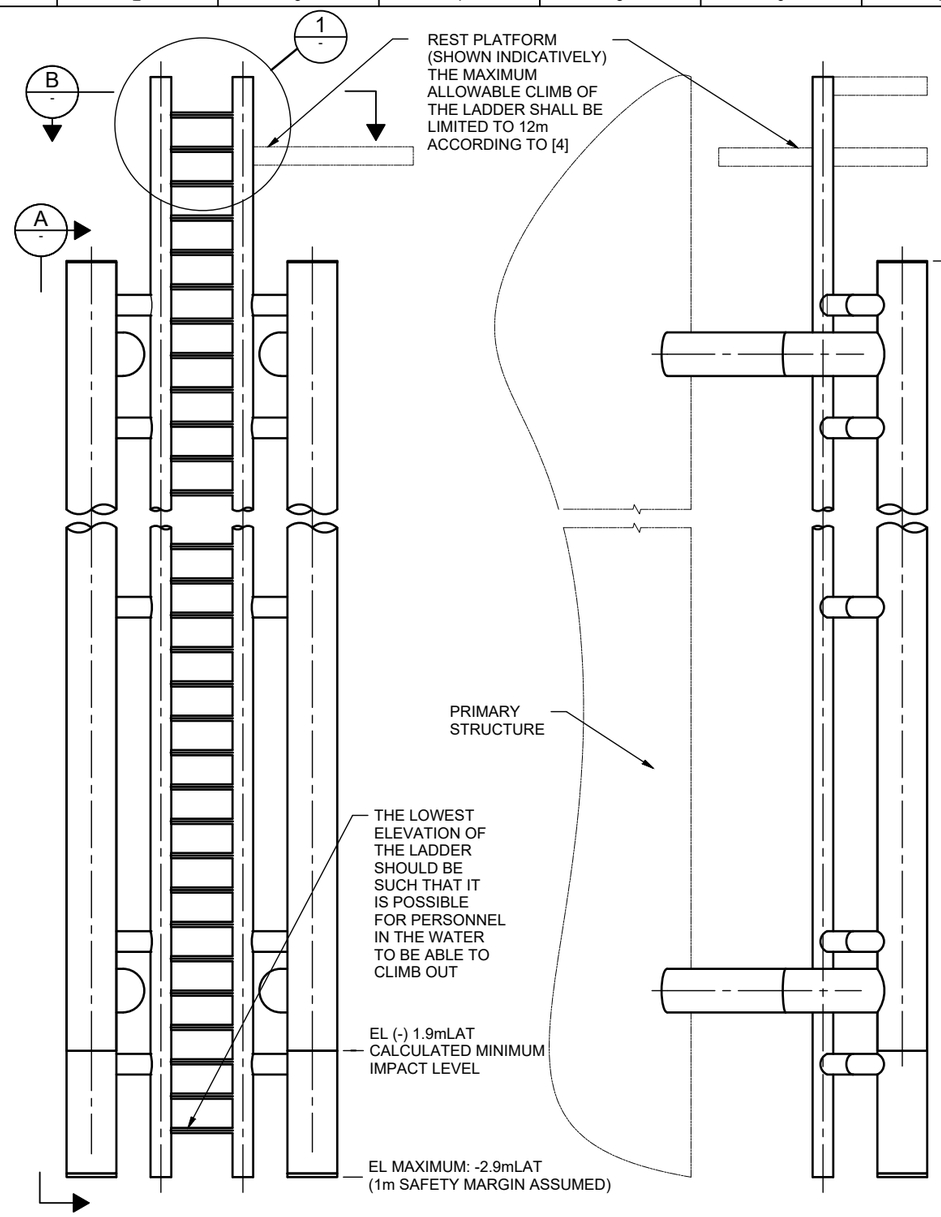
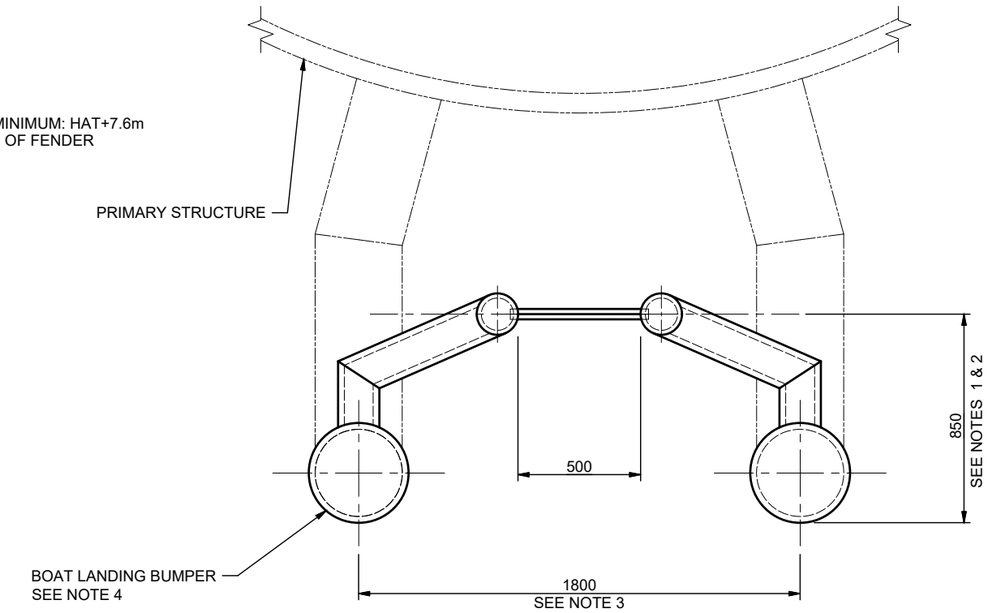
Atkins Drawing Number: 5166244-ST-DRG-0004

Client Drawing Number: OWA-A-RBD-ATK-DWG-0004

Revision: 02

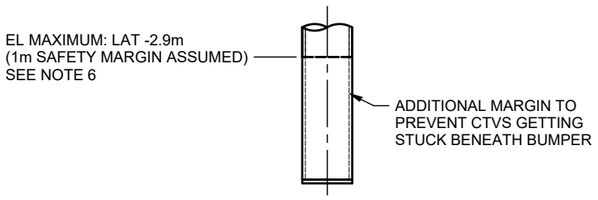


BOAT LANDING SYSTEM ELEVATION
SCALE 1:50

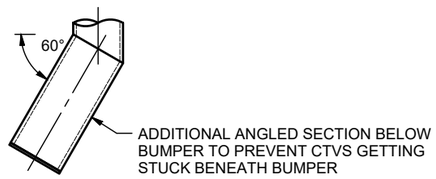


SECTION B - BOAT LANDING SYSTEM PLAN VIEW

SECTION A -
SCALE 1:50

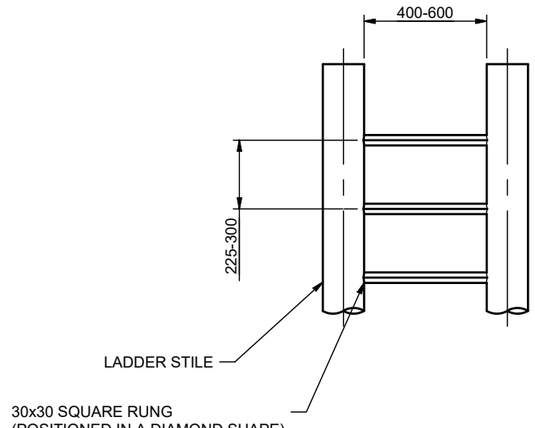


STRAIGHT EXTENSION
SCALE 1:50



ANGLED EXTENSION
SCALE 1:50

BOAT LANDING BUMPER LOWER END OPTIONS
SEE NOTE 5



DETAIL 1 -

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

OTHER THAN THE HAZARDS/ RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NO FURTHER SIGNIFICANT RISKS HAVE BEEN IDENTIFIED

1. ANY REST PLATFORM SHALL BE POSITIONED SUCH THAT IT DOES NOT INTERFERE WITH THE SAFETY ZONE BETWEEN THE VESSEL AND THE LADDER, OR CREATE A RISK BY BEING HIT BY A MOVING VESSEL.
2. CARE AND ATTENTION IS REQUIRED WHEN CLIMBING DUE TO INHERENT RISKS OF SLIPS AND TRIPS.
3. THE HEIGHT OF LADDER CLIMB SHALL WHERE POSSIBLE BE MINIMISED TO REDUCE FATIGUE OF PERSONNEL DURING CLIMBING.

GEOMETRY NOTES

1. AN OVERALL SETTING OUT DISTANCE OF 850mm IS RECOMMENDED, AS MEASURED FROM THE LADDER RUNG CENTERLINE TO THE OUTER FACE OF THE BUMPER BAR.
2. THIS DIMENSION IS BASED ON A CTV FENDER NIPPLE DEPTH OF 230mm. A CLEAR SAFE ZONE MINIMUM 500mm FROM LADDER FACE SHALL BE MAINTAINED AT ALL TIMES TAKING INTO ACCOUNT CTV FENDER COMPRESSION. A MAXIMUM DISTANCE OF 650mm FROM CENTRE LINE OF LADDER TO NON-SLIP SURFACE ON THE CTV SHALL BE ALLOWED TO OBTAIN A SAFE STEP OVER DISTANCE [6].
3. THE DISTANCE BETWEEN CENTRELINES OF BUMPER IS SHOWN AS 1800mm. THIS IS A RECOMMENDED VALUE TO BE USED ACROSS DIFFERENT WIND FARM DEVELOPMENTS TO IMPROVE CONSISTENCY AND AID OPERATIONS [5].

GENERAL NOTES

4. A BOAT LANDING BUMPER DIAMETER OF 406mm HAS BEEN USED FOR THESE CALCULATIONS, BUT EXACT DIAMETER IS NOT SPECIFIED WITHIN THESE GUIDELINES. BUMPER DIAMETER MAY HOWEVER HAVE AN EFFECT OF NOVEL BOAT LANDING TECHNOLOGIES.
5. TWO END OPTIONS ARE SHOWN AS EXAMPLES OF DETAILS WHICH REDUCE THE RISK THAT THE CTV WILL GET TRAPPED BENEATH THE BOAT BUMPER. OTHER OPTIONS CAN BE CONSIDERED.
6. A SAFETY MARGIN OF 1m HAS BEEN INCLUDED BELOW THE LOWEST CALCULATED CTV IMPACT LEVEL. THE ACCEPTABLE SAFETY MARGIN SHOULD BE REVIEWED FOR EACH PROJECT. ADDITIONALLY, FURTHER DETAILS CAN BE ADDED TO REDUCE RISK OF ENTRAPMENT OF VESSEL - SEE NOTE 5.

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02	09/12/2019	ISSUED FOR REVIEW	OA	OA	AD
01	04/09/2019	ISSUED FOR REVIEW	OL	WH	OA

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PLAN VIEW AND DETAILS

Scale	Package Code	Drawn	Checked	Authorised
1:25		OL	WH	OA
Original Size	**Functional Area**	**Date**	**Date**	**Date**
A3		04/09/2019	04/09/2019	04/09/2019

Atkins Drawing Number: 5166244-ST-DRG-0005

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Revision: 02