STRESS SUBSEA, INC.
HOUSTON, TEXAS

DEEP WATER RESPONSE TO UNDERWATER PIPELINE EMERGENCIES – DW RUPE

Phase 1 – Final Report

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1.0 ABSTRACT

This report addresses the first phase of a JIP formed for the development of emergency repair capability for pipelines and flowlines in water depths in the 1,000-10,000 ft range, in the US Gulf of Mexico. Stress Subsea (SSI) conducted a Failure Mode and Effects Analysis, conducted interviews with suppliers and operators and, included input from the JIP's Steering Committee, to make recommendations for two different repair methods to support the emergency repair of larger diameter pipelines and flowlines, respectively.

For larger diameter pipelines the recommendation is to use two "structural" leak clamps to make spool piece repairs, or use one of the two to clamp a pinhole leak. The use of the same clamp design for either application avoids needing three separate tools. For flowline repair, the recommendation is to cut the flowline on bottom, lift the ends to the surface to add fittings, then lay the flowline ends on bottom to join them with a vertical jumper containing twin collet connectors. Major pipe damage and pinhole leaks would be repaired the same way.

2.0 INTRODUCTION

The JIP participants are Williams, GulfTerra, Chevron, Kerr Mcgee, Anadarko, ENI Petroleum, Unocal, Enbridge, the US Department of Transportation and the U.S. Department of the Interior, Minerals Management Service. The Steering Committee and their affiliation consists of:

Alan Schneider, Chairman	Enbridge
Don Beesley	ENI Petroleum
Michael Carlson	Williams
Michael Else	MMS/DOT
Mike McEvilly	Anadarko
Mike Stark	GulfTerra/Enterprise
Roger Bergman	ChevronTexaco
Sanjay Sinha	Unocal
Tim Dean	Kerr-McGee

Starting with a collection of operator/participants pipe "dedications", the JIP prepared a Design Basis which served as guidance for various equipment inquiries and requests for quotes. These pipe dedications defined, among other things, size, length, wall thickness, grade and the MAOP of the dedicated pipelines. Interviews where conducted with key deepwater products manufacturers, installation and repair contractors, as well as operators with experience in developing deepwater repair methods.

Throughout the project, SSI held 5 project meetings, met with BP and Shell for their views and lessons learned, and met with industry leaders such as Sonsub, Oceaneering, Oilstates, Quality Connector Systems, Canyon Offshore and Deep Marine Technology to get their input and advice. SSI also interfaced with companies such as FMC and Grayloc, as well as a number of other smaller sub suppliers.

The intent of the interview process was to sum up the most recent knowledge and experience, thus avoiding "reinventing the wheel", and allowing for a fast decision making on what would be our low CAPEX, cost effective solution for deepwater pipeline repairs.

Based on information obtained from the MMS database, SSI prepared a Failure Mode and Effects Analysis (FMEA), to predict what failure modes would be more likely in the deep water environment. The results of the FMEA where used in selecting the candidate repair methods for DW RUPE.

Our recommendations contained in this report are thought to be an up-to-date, comprehensive discussion of the deepwater repair scenarios, and they provide cost effective solutions to meet the requirements set forth by the Steering Committee.

Definition of Terms

- Non-Structural Repair Clamp — A diverless split clamp with radial and longitudinal seals, used when the pipe to be repaired has sustained a pinhole leak damage. The Non-Structural Repair Clamp is a permanent repair.
- Structural Clamp Connection — A diverless split clamp with radial and longitudinal seals, used when the pipe to be repaired has sustained structural damage. The Structural Repair Clamp is a permanent repair.
- Collet Connector — Collect connector consists of a body and hub whereby individual "fingers" or collets, arranged in a circular pattern and attached to the body, engage the hub to form a fully structural connection. This engagement is either mechanically or hydraulically actuated.
- Pollution Control System — Some method of minimizing pollution during repairs may be offered, e.g. underwater "tents", collection bags, pipe lift to create seawater hydraulic locking of oil residues within the pipe, etc. Refer to Appendix 7 for additional information.
- Spool Piece Connection — Generally, an in-line spool piece connection consists of a horizontal replacement pipe section connected to the adjacent pipeline using one of several available diverless connection systems.

- Vertical Jumper Connection — The vertical jumper assembly is typically made of two female collet connectors linked by a piece of pipe that has been shaped to various forms. The shape and length of the pipe jumper will vary with the predicted loads and displacements required (e.g. due to thermal expansion, etc.

3.0 CONCLUSIONS

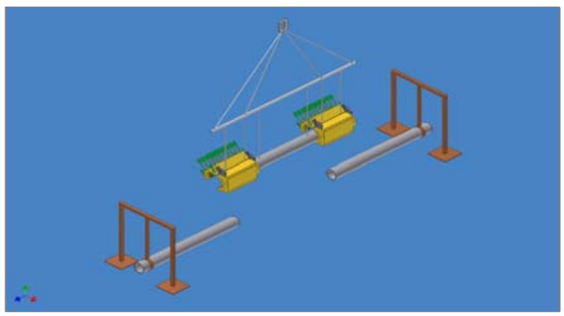
Results from Deepwater RUPE, Phase 1, the following conclusions can be drawn:

- The probability of needing a deepwater repair is low, but the consequences are high.
- The most likely damage types are wet and dry buckles caused by anchor snags (the DW RUPE low water depth range is 1,000 ft., hence anchoring is still considered).
- Potential repair solutions for a low CAPEX pipeline repair and a low CAPEX flowline repair are different.
- Traditionally a leak clamp and a spool piece connector set is needed for each pipe size. The new paradigm of employing full structural clamps as connectors, and in place of connectors, allows two clamps to be used in a spool piece repair or one of the structural clamps to be used alone for a pinhole leak from a cracked weld. So, two clamps will serve the same function as two connectors and a clamp (Pipeline Repair).
- For pinhole leaks, the most likely cause will be cracked welds, thus full structural clamps are advised to arrest crack propagation (Pipeline Repair).
- Use of structural clamps for pipeline spoolpiece connections requires structural and SIT testing (Phase 2A)
- Use of Collet Connectors with vertical jumpers has already been validated in the field, thus the concept needs no qualification testing.
- Avoiding “slip on” connectors minimizes elastomer seal damage caused by rough cut ends of the pipe.
- For Flowline repairs, use of collet connectors with inserts minimizes the number of connectors required
- Use of pollution deepwater control tents and bags to collect spilled oil during a repair is fraught with problems. Careful placement of lift frames to create containment “humps” during pipe cutting, and use of pumpable plugs during spool piece installation will minimize pollution. See Appendix 7 for details.

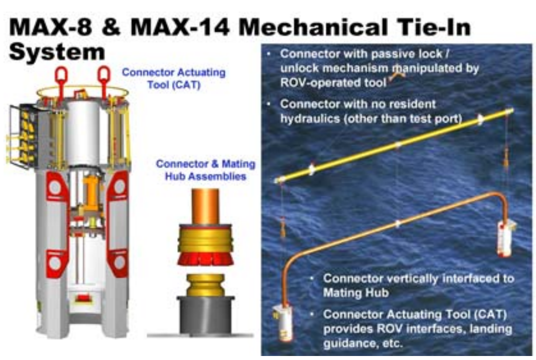
4.0 RECCOMENDATIONS

As a result of the work conducted under the DW RUPE JIP, SSI recommends the creation of subgroups within DW RUPE: DW RUPE Pipe Lines (DW RUPE PL) and DW RUPE Flow Lines (DW RUPE FL).

- The *pipeline* repair system is characterized by larger diameters (10" to 24") and lower pressure (10" clamp is ANSI 2500 rated, and 12" to 24" clamps are rated ANSI 1500). Repairs are conducted subsea, and are based on spool piece connections with a set of structural clamps. Depending on the extent of damage, the repair could be performed using either a single clamp or a set of clamps connected to a pipe spool piece.



- The *flowline* repair system is characterized by smaller diameter (4" to 10"), high pressure (up to 15,000 psi) pipe. Repairs are conducted by cutting the pipe subsea, then recovering it to the surface, where PLETS are installed. The final connection is by means of a jumper with mechanically actuated collet connectors. The DW RUPE FL Co-Owners will keep a set of pre-designed PLET blueprints on file, and warehouse the long lead materials, so PLETS can be fabricated for specific sizes in minimal time in the event of a repair emergency.



- Qualification testing is required for the clamped spool piece approach prior to making large tool expenditures (Phase 2A)

- *Both* groups, the PL and the FL Groups, will use a set of common tools, for which the cost will be shared, and have separate tools for the specific repair methods, which are further described, as follows:

  - **COMMON TOOLS**

    For pipelines and flowlines:

    - Lift Frames (2 each), size range 4” to 24”
    - Pipe Cutting System, size range 4” to 24”

  - **DW RUPE PL**

    - Non Size Specific Tools
      - FBE and Weld Removal Tool
      - Running Tools
    - Size Specific Tools
      - 2 ea. 10” Structural Clamps
      - 2 ea. 12” Structural Clamps
      - 2 ea. 14” Structural Clamps
      - 2 ea. 16” Structural Clamps
      - 2 ea. 18” Structural Clamps
      - 2 ea. 24” Structural Clamps

  - **DW RUPE FL**

    - Non Size specific tools exclusive to flowlines: None
    - Set of 8 induction bent pipe for each size (4”, 5”, 6”, 7”, 8” and 10”)
    - Set of pipe materials (4”, 5”, 6”, 7”, 8” and 10”)
    - Set of two male/female collet connectors and hubs for 10” flowline
    - Set of inner bodies (8”, 7”, 6”, 5” and 4”)

- We recommend that a DW RUPE Phase 2B Co-Ownership organization be formed to jointly purchase, store, maintain and manage both pipeline and flowline repair systems to be dispatched for use by a Co-Owner in making a deepwater pipeline or flowline repair.

4.0 SCOPE OF WORK

The objectives of the phase 1 project are as follows:

- Identify pipeline and flowline size ranges of participants, including insulated and non insulated conventional pipe, as well as pipe-in-pipe options as applicable.

- In order to understand what repair scenarios will be expected, identify and evaluate expected pipeline and flowline damage conditions, using the damage categories outlined in the MMS database of Gulf of Mexico pipeline leaks.
- Provide a technical and cost evaluation of deepwater pipeline and flowline repair alternatives resulting in a recommended repair system for each identified damage condition. Identify potential repair vessels, ROV's and other tools of opportunity.
- For the recommended solution, develop conceptual plans and procedures for effecting repairs for each system, including repairs during both construction and operations.
- Develop a project execution plan for constructing the recommended system for the next phase of the project.
- Perform the background work required to fund the second phase DW RUPE JIP, including procurement, integration of equipment and, where needed, component and SIT testing of the selected system components.

5.0 SEQUENCE OF EVENTS

The following gives the sequence of evens for DW RUPE, Phase 1:

Based on participants dedications, SSI developed a Design Basis for the project (Reference [1]), which was incorporated to the project once comments where received from the participants.

- SSI conducted a series of interviews with SONSUB, OILSTATES, QUALITY CONNECTOR SYSTEMS (QCS), OCEANEERING, CANYON OFFSHORE and DEEP MARINE TECHNOLOGY (DMT). Each company was issued a request for information document ("RFI", Appendix 2), and informed their specific areas of interest/expertise.

- Following the RFI, SSI issued a second document, the Request for Quote (RFQ, Appendix 3), in the form of a tender document. Except CANYON OFFSHORE, all of the above companies replied to the RFQ.

- SSI reported the result of the bid process to the Steering Committee and participants. The following options where discarded:

    - *Non-Structural Clamp*: Not cost effective, since structural clamps will provide a final solution for either structural and non structural defects for a small increase in CAPEX.
    - *Pollution Control System*: Although not a very high cost item, the pollution control system creates an obstacle for repair equipment handling, a spot for ROV tethers to entangle, while being of questionable value as far as the recovery of pollutants. SSI suggested the Steering Committee to consider a hydraulic lock system (see Appendix 7), considering oil pollutants density is less than seawater,

while the pipe is being cut, following the insertion of a mechanical plug by an ROV. The mechanical plug would later be driven out of the pipe by internal pressure, as a pig would.

- *Pipe Leak Location System*: Not offered directly by any of the interviewed offshore service companies, not a repair component. Call out services are available from Come Monday, Inc., a GOM based service provider
- *"Band Aid" Temporary Repair System*: Offered in the form of non-structural repair clamps, not cost effective.

- SSI recommended an "all clamp" solution to the steering committee.
  - As the "all clamp" solution was discussed, it became clear that operators with predominant flowline dedications had a different expectation. The primary differences are the pressure levels, which could be as high as 15,000 psi for the flowlines, and the remote removal of hard insulation (e.g. Glass Reinforced Polyurethane (GSPU)).
  - Also, flowlines are lighter and therefore easier to recover to the surface when compared with export flowlines.
  - As a result of these discussions, SSI proposed two distinct DW RUPE groups, which would still use a set of common tools and thus mutually benefit from the overall cost split.
  - As part of the next phase Project Execution Plan, SSI proposed the path forward to be conducted in three steps, as follows:
    - Phase 2A will be the qualification program for the DW RUPE PL group. Because the structural repair clamp requires qualification testing, DWRUPE PL has to evaluate the suitability of the clamps through a design verification process, together with structural integrity and systems integration testing.
    - Phase 2B - DW RUPE PL will be the manufacturing phase for the DW RUPE PL group, after completion of phase 2A.
    - Phase 2B – DW RUPE FL will be the manufacturing and procurement of the DW RUPE FL. Since the 15,000 psi collet connectors are proven technology, the DW RUPE FL could start as soon as agreements are completed.
    -

6.0 FAILURE MODE AND EFFECTS ANALYSIS

The FMEA (Appendix 1) considered three basic phases of the design life of a pipeline or flowline: Installation, Hydrostatic test, and Operation. A range of water depths, from 1,000 ft, where mooring accidents are still possible, to 10,000 ft, where weld cracks, thermal buckles (flowlines) and inline equipment leaks are more likely where considered. The ranking for the failure events is the product of three factors:

- The *severity index*, ranked from 1 (no discernible effect on product or subsequent processes) to 10 (hazardous effect, safety compromised, noncompliance with government regulations) defines how hazardous a failure is likely to be.
- The *occurrence index*, ranked from 1 (failure unlikely, history shows no failures) to 10 (failure almost certain) defines the likelihood of a failure.
- The *detection index*, ranked from 1 (almost certain detection) to 10 (almost impossible to detect failure) defines the difficulty of detection of a failure.

The *risk priority index* (RPI) is the product of the three factors, and it's value defines the overall ranking of a *failure mode*, during one of the three phases of the pipeline or flowline life.

7.0 REQUESTS FOR INFORMATION – REQUESTS FOR QUOTES

7.1 – Request for Information Form (Appendix 2)

The intent of the RFI was to establish potential suppliers of products and services areas of expertise, and what products and equipment they would keep "on the shelf", thus avoiding capital expenditures with non critical items.

The RFI organizes the areas of interest in 5 main groups:

- Group I - Generic Tools
  - Pollution Control Systems
  - Pipe Lift Frames
  - Pipe Cutting System
  - End Preparation Tools
  - On-Bottom FBE and Weld Seam Removal Tool
  - Pipe Plug and Lift Tool
  - Pipe Measurement System
  - Pipe Leak Location System

- Group II - Clamps
  - Structural Repair Clamps
  - Non Structural Repair Clamps

- Group III - On Bottom Spool Piece Repair System
  - In-Line Connection
  - Jumper Connection

- In-Line Flex Loop (Optional)

- Group IV – Temporary Repair
  - "Band-Aid" Temporary Repair System

- Group V – Survey and Construction Services
  - ROV Services
  - Dynamic Positioning Vessel Services (On-Bottom Work)
  - Dynamic Positioning Pipe Lift/Lay Vessel Services

7.2 – Request for Quote Package (Appendix 3)

The request for quote package established clear rules for the participating contractors and manufacturers to bid on their respective areas of expertise, defined during the RFI phase.

The DW RUPE costs derived from the costs offered by participating manufacturers and contractors.

8.0 CURRENT STATE OF THE ART – PROPOSED REPAIR SYSTEMS

The following repair scenarios were developed for deepwater pipeline and flowlines.

8.1 DW RUPE Pipeline Repair System (DW RUPE PL)

Repair clamps have been in the market since the 70's. The selected clamps are intended for structural service, meaning they will hold two separate ends of a pipeline, under hydrostatic and service conditions. The novelty resides in the fact that these clamps can be used either with minor damage, i.e. pinhole type leak, in which case only one clamp is used, or in repairs that require the replacement of a short section of pipe. The repair work is thought to be simple, being conducted from a small dynamically positioned vessel equipped with an ROV and limited craneage. Figures 8.1-1 through 8.1-2

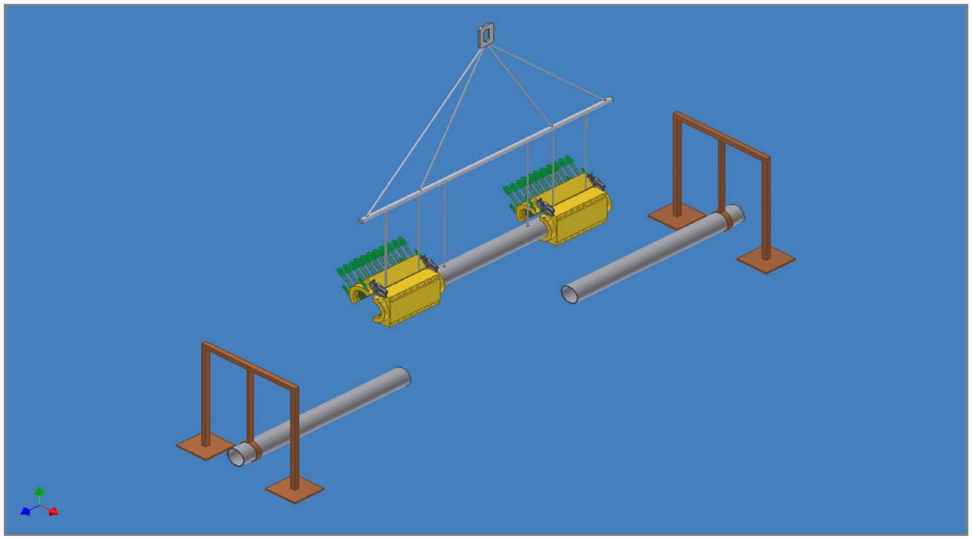


Figure 8.1-1 – Inline Spool Installation

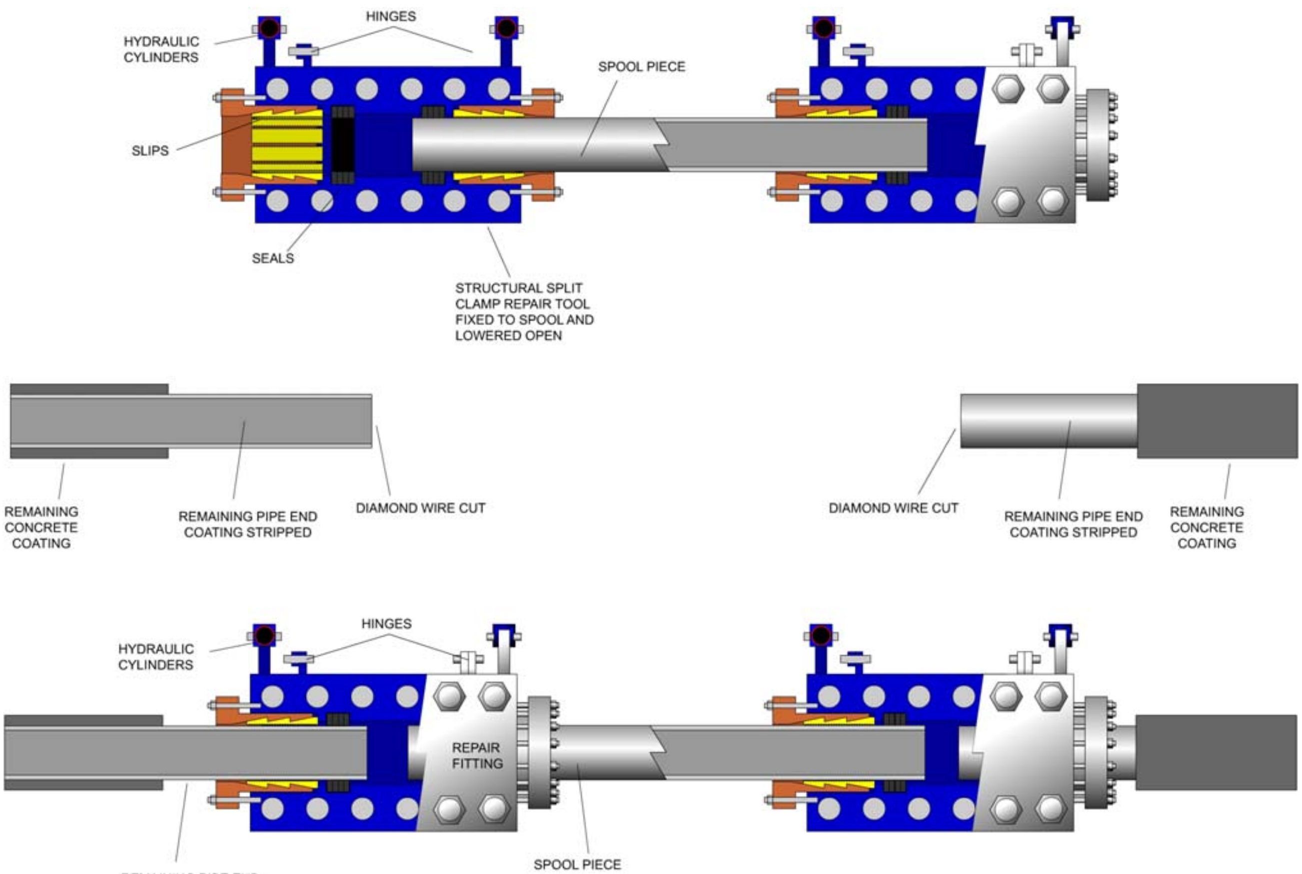


Figure 8.1-2 – Inline Spool Cross Section

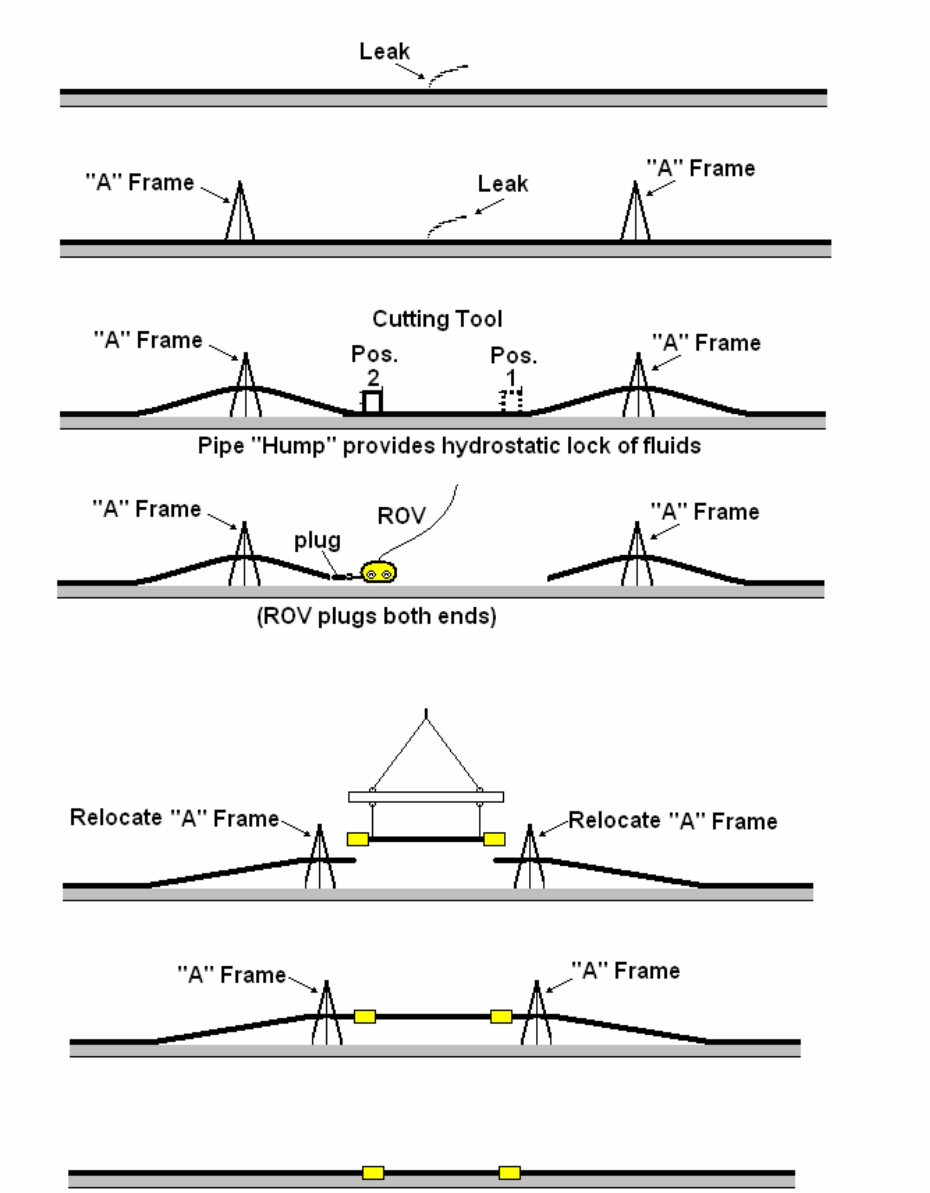


Figure 8.1-3 Installation Sequence

8.2 DW RUPE Flowline Repair System (DW RUPE FL)

Due to their maximum size being limited to 10" nominal, there is a number of vessels capable of lifting the flowlines to the surface. Although the surface repair is thought to be more costly, it requires a small CAPEX. For DW RUPE FL, it is assumed some of the equipment will be available from the installation and subsea construction contractors. Pull heads (e.g. "ballgrab", rented by Baltec), subsea measurement tools (e.g. as used by SONSUB), and the mechanical collet connector running tools will be rented as necessary. The equipment DW RUPE FL has in common with DW RUPE PL are the Lift Frames and the Cutting System.

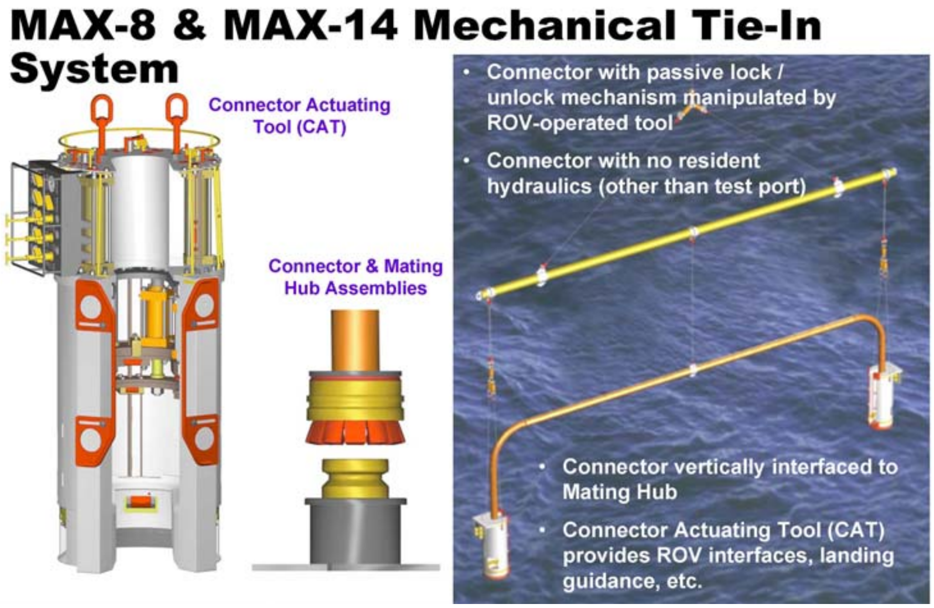


Figure 8.2-1 – Mechanical Collet Connector

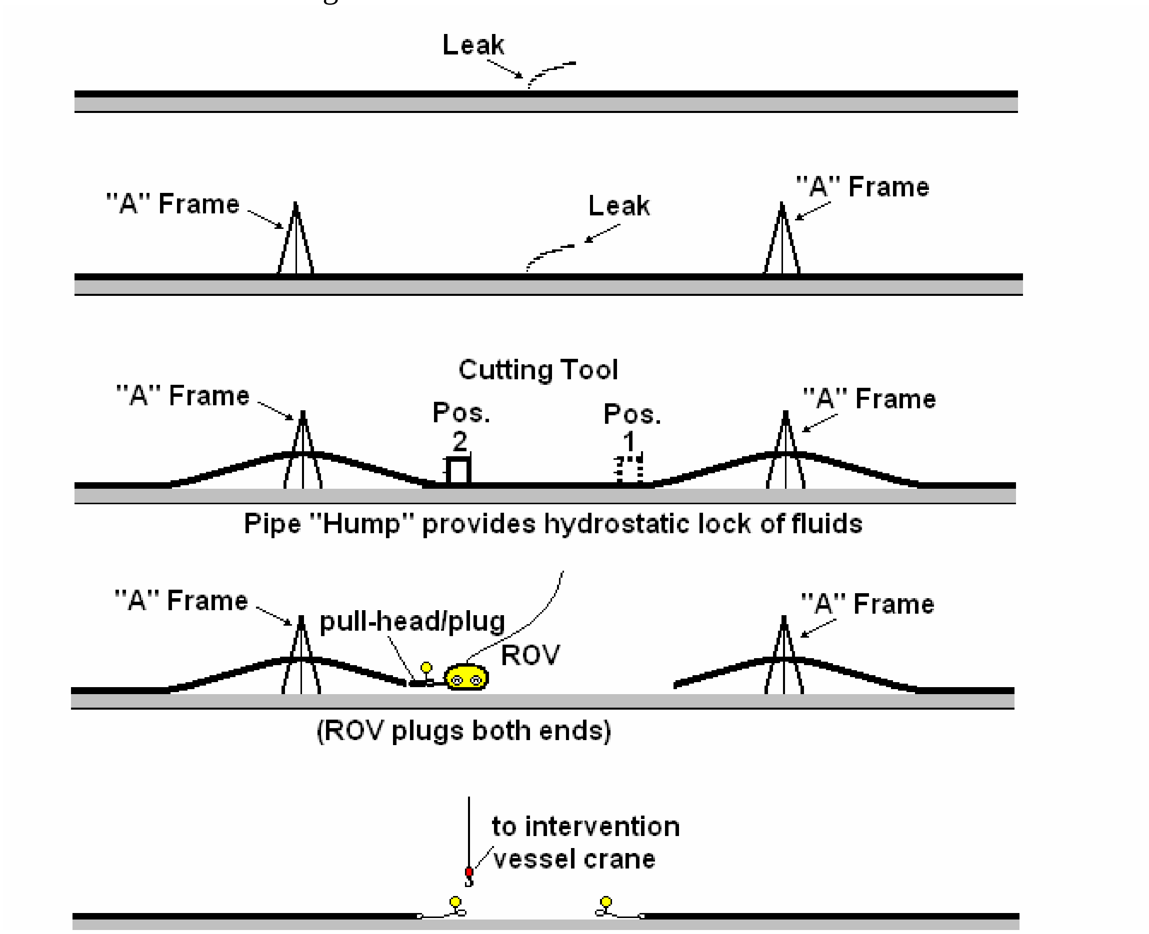


Figure 8.2-2 Flowline Repair Installation Sequence

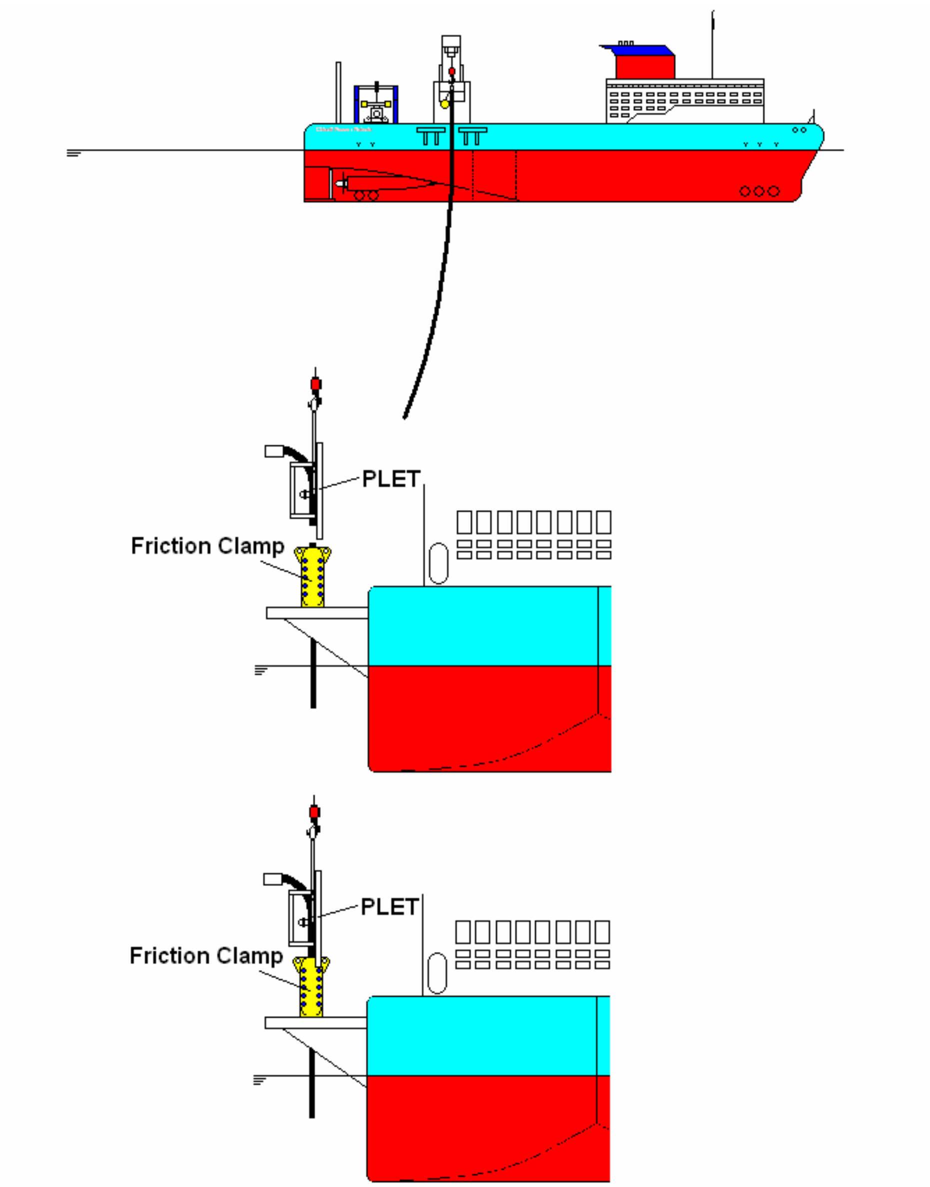


Figure 8.2-2 Flowline Repair Installation Sequence (cont)

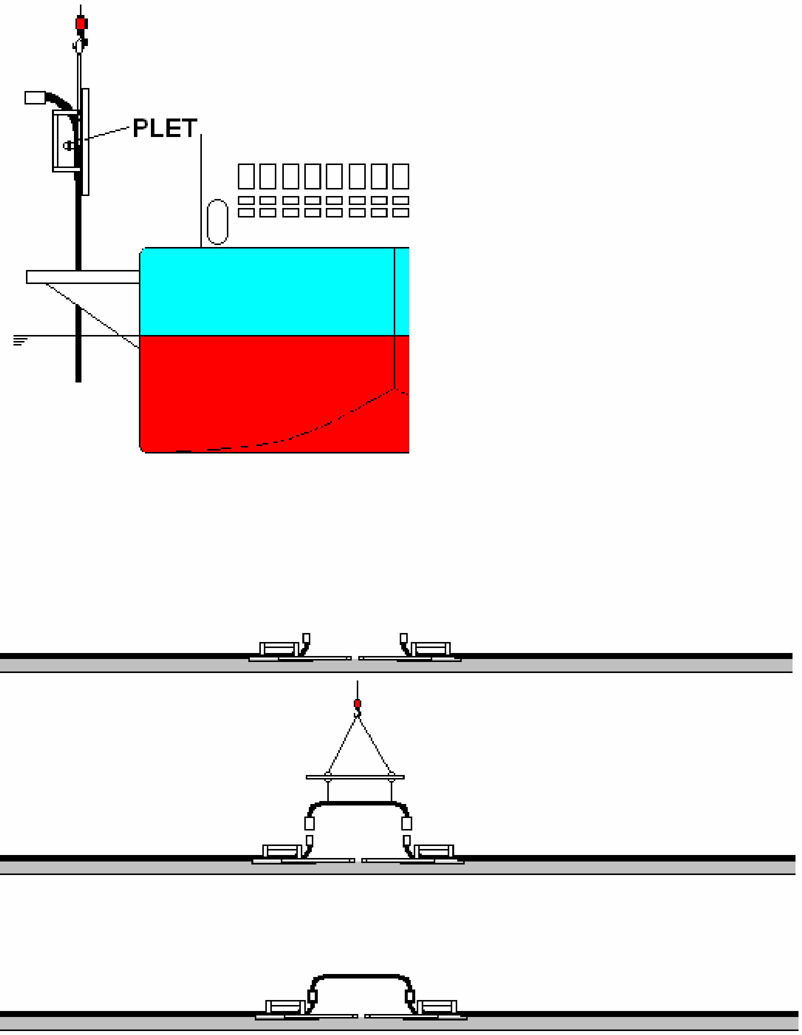


Figure 8.2-2 Flowline Repair Installation Sequence (cont)

9.0 DW RUPE – COSTS

SSI received proposals from SONSUB, Oceaneering, Quality Connector Systems, Oil States, Deep Marine Technology, FMC Technologies, Grayloc, and Bendco. Since the responses included only parts of the respective systems, every proposal was normalized with "lowest cost per item", and then presented to the Steering Committee. The DMT and Graylock proposals where based on conceptual designs, and would require a higher level of engineering and product qualification, and where rejected on that basis.

At the time the proposals where evaluated, the “small” diameter option included a range of 4” to 10” pipe, and the “large” diameter included a range of 12” to 24” diameter.

After the recommendation and selection process, a low pressure 10” clamp option was included in the “large” group, which then became the DW RUPE PL group.

Figure 9.1 shows the global, per company normalized costs (for both large and small diameters).

Figures 9.2 and 9.3 show the normalized costs per group, and figure 9.4 show the combination of possible solutions.

After the selection process, SSI proceeded with a separate investigation on the use of collet connectors, and another cost group was assembled for the DW RUPE FL. The proposal for FMC collet connectors is presented in Appendix 4, and the quote for induction bends is included in Appendix 5.

The global cost distribution for the selected systems is shown in figure 9.5.

Normalized Summary - Phase 2

	QCS			SONSUB			Oceaneering			Oil States		
	Qty	Sub Total	Notes	Qty	Sub Total	Notes	Qty	Sub Total	Notes	Qty	Sub Total	Notes
Pollution Control System			20			20			20			20
Pipe Lift Frame	2	$578,544		2	$578,544	2	2	$578,544	2	2	$594,830	1
Diamond Wire Saw	1	$308,125		1	$308,125		1	$308,125		1	$308,125	
End Preparation Tool			19	1	$110,500		3	$840,500	3	1	$110,500	21
FBE & Weld Seam Removal tool			19	1	$639,800		3	$323,158	4	1	$639,800	5
Pipe Plug and Lift Tool	6	$480,000	8	0	$0	6	0	$0	14	0	$0	7
Pipe Measurement System	1	$79,100	9	1	$86,700		1	$79,100		1	$79,100	9
Structural Repair Clamp (4"-10")	6	$1,245,000	10	6	$1,245,000	22	6	$1,245,000	22	6	$1,245,000	22
Running Tools (all)	6	$580,000	11	12	$896,300	12	6	$580,000	13	12	$795,892	15
Structural Repair Clamp (12"-24")	10	$3,180,000	16	5	$1,590,000	22	5	$1,590,000	22	5	$1,590,000	22
In-line connection		$0			$4,518,673	18	11	$5,144,900	17	11	$4,518,673	17
Project Management and Engineering	1	$200,000			$0			$0		1	$1,448,200	
Total		**$6,650,769**			**$9,973,642**			**$10,689,327**			**$11,330,120**	
Repair Hardware Only		**$5,485,000**			**$8,249,973**			**$8,559,900**			**$8,149,565**	

Note #	Comments
1	Oil States, used their offer for a 4" to 24" with 2 sets of clamps. "A" frame for vertical lift only, assumed 20% for traverse
2	Used the largest Oceaneering "A" Frame and added 20% for adding extra clamp
3	Oceaneering offers three end preparation tools
4	Oceaneering system is only for FBE removal, the seam removal is combined with the end prep tool
5	Used SONSUB's price to normalize the Oil States quote since the Oceaneering Component does not include weld seam removal
6	Used Oceaneering's plug and lift to normalize the SONSUB quote
7	As Oceaneering, Oilstates uses the Inline method for all sizes, therefore the recovery has been "zeroed".
8	Use the Structural Clamp with Lift Head Assembly, or build dedicated recovery clamp with inserts, to recover insulated pipe.
9	Used the Oceaneering price to normalize the QCS and Oil States quotes
10	Note the "unit price" is an average for the total cost of the clamps
11	Note the "unit price" is an average for the total cost of the running tools
12	For SONSUB, added the Deployment Frame for three tools, the Hydraulic Tool & Manifold and the QCS Running Tools
13	Oceaneering running tools are included with the inline connection price. This line deals with the QCS Running tools needed for the structural clamps
14	Oceaneering prescribes the inline method for all sizes, so the plug and lift tool is not required (although quoted)
15	Oil States: Added the three sets of mudmat and guidance systems then averaged, added the QCS Running Tools.
16	QCS, 2 each structural clamps for each size 12" through 24", for a total of 10 units. The average cost is $318,000
17	Oceaneering and Oil States, averaged total cost * 11 sizes, note Oil States does not meet the Design Basis for some sizes
18	Since SONSUB does not quote repair systems, costs have been normalized based on the lowest hardware (Oil States Inline)
19	We have assumed the QCS system does not require a weld seam, FBE removal tool, or an end preparation tool.
20	Assumed the "hump" system will be used for all systems.
21	Used the SONSUB system to normalize
22	Used 1 QCS Structural Clamp for each size to normalize: Assume the structural clamps are still needed in case of pinhole and damage less than 1 x OD in length

Figure 9.1 – Global Normalized Cost

Normalized Summary Small OD Only - Phase 2 Lift Repair and Connection + On Bottom Pinhole Leak Repair	QCS			DMT			Graylock		
	Qty	Sub Total	Notes	Qty	Sub Total	Notes	Qty	Sub Total	Notes
Pollution Control System (none)			1			1			1
Pipe Lift Frame (Oceaneering)	2	$578,544	2	2	$578,544	2	2	$578,544	2
Diamond Wire Saw (SONSUB)	1	$308,125		1	$308,125		1	$308,125	
End Preparation Tool (None)			3			3			3
Alignment and Bolting Tool (DMT)				1	$1,096,000	8			
FBE & Weld Seam Removal tool (None)			3			3			3
Pipe Plug and Lift Tool (Based on QCS)	6	$480,000	4	6	$480,000	4	6	$480,000	4
Pipe Measurement System (Oceaneering)	1	$79,100	5	1	$79,100	5	1	$79,100	5
Structural Repair Clamp (4"-10")(QCS)	6	$1,245,000	6	6	$1,245,000	6	6	$1,245,000	6
Running Tools (4"-10")	3	$180,000	7	1	$180,000	7	1	$100,000	10
Flanges or hubs	n/a			24	$62,808	9	24	$86,466	11
Project Management and Engineering			12			12			12
Total		$2,870,769			$4,029,577			$2,877,235	
Repair Consumables		$1,905,000			$1,487,808			$1,431,466	

Note #	Comments
1	Assumed the "hump" system will be used for all systems.
2	Used the largest Oceaneering "A" Frame and added 20% for adding extra clamp
3	End preparation, FBE and insulation removal done at the surface.
4	Either use structural clamp, or build dedicated recovery clamp with inserts.
5	Used the Oceaneering price.
6	Use QCS pricing for all, structural clamps to cover pinhole or less than 1 x OD damage.
7	QCS, 3 each running tools for 6 each sizes
8	Alignment and bolting tool as quoted by DMT
9	Awaiting one of the vendors to confirm: Texas Flange or Woodco
10	Allowed $100,000 for male hot stab.
11	Per Grayloc Products quote
12	Included in large diameter if applicable

Figure 9.2 – Small OD Normalized Cost

Normalized Summary Large Diameters - Phase 2
Spool Piece Connection + On Bottom Pinhole Leak Repair

	QCS			SONSUB			Oceaneering			Oil States		
	Qty	**Sub Total**	**Notes**	**Qty**	**Sub Total**	**Notes**	**Qty**	**Sub Total**	**Notes**	**Qty**	**Sub Total**	**Notes**
End Preparation Tool			1	1	$110,500		3	$840,500	7	1	$110,500	11
FBE & Weld Seam Removal tool			1	1	$639,800		3	$323,158	8	1	$639,800	12
Running Tools (14", 18" and 24")	3	$400,000	2	5	$716,300	4	3	$400,000	9	6	$555,609	13
Structural Repair Clamp (12"-24")(QCS)	Use one of inline clamps			5	$1,590,000	5	5	$1,590,000	5	5	$1,590,000	5
In-line connection	10	$3,180,000	3	5	$2,781,011	6	5	$3,038,000	10	5	$2,781,011	10
Project Management and Engineering	1	$200,000			$0			$0		1	$1,448,200	
Total	$3,780,000			$5,837,611			$6,191,658			$7,125,120		

	QCS	SONSUB	Oceaneering	Oil States
Repair Consumables	$3,580,000	$5,087,311	$5,028,000	$4,926,620

Note #	Comments
1	We have assumed the QCS system does not require a weld seam, FBE removal tool, or an end preparation tool.
2	Note the "unit price" is an average for the total cost of the running tools
3	QCS, 2 each structural clamps for each size 12" through 24", for a total of 10 units. The average cost is $318,000
4	For SONSUB, added the Deployment Frame for three tools, the Hydraulic Tool & Manifold and the QCS Running Tools
5	Used 1 QCS Structural Clamp for each size to normalize: Assume the structural clamps are still needed in case of pinhole and damage less than 1 x OD in length
6	Since SONSUB does not quote repair systems, costs have been normalized based on the lowest hardware (Oil States Inline)
7	Oceaneering offers three end preparation tools
8	Oceaneering system is only for FBE removal, the seam removal is combined with the end prep tool
9	Oceaneering running tools are included with the inline connection price. This line deals with the QCS Running tools needed for the structural clamps
10	Oceaneering and Oil States, averaged total cost * 11 sizes, note Oil States does not meet the Design Basis for some sizes
11	Used the SONSUB system to normalize
12	Used SONSUB's price to normalize the Oil States quote since the Oceaneering Component does not include weld seam removal
13	Oil States: Added the two sets of mudmat and guidance systems then averaged, added the QCS Running Tools.

Figure 9.3 – Large OD Normalized Cost

COMBINED COSTS (Million USD)						
Small OD → / ↓ Large OD ↓	QCS	DMT	Grayloc	SONSUB	Oceaneering	Oil States
QCS	$6.65	$7.81	$6.66			
SONSUB	$8.71	$9.87	$8.71	$9.97		
OCEANEERING	$9.06	$10.22	$9.07		$10.69	
OIL STATES	$10.00	$11.15	$10.00			$11.33

Figure 9.4 – Combined Costs

DW RUPE COMMON TOOLS
Base Tool Kit (all)
Lift Frame(Oceaneering): $600,000
Cutting System(SONSUB):: $308,000
Measurement Tool(Oceaneering): Rental

Total $908,000

DW RUPE PIPELINES
Non Size Specific

FBE and Weld Removal Tool(SONSUB): $640,000
Running Tools (SONSUB): $316,300
Total $956,300

DW RUPE FLOWLINES
Non Size Specific
Pair of pre-fabricated PLETS: None
Ship's Repair Frame: Repair contractor

Total $0.00

DW RUPE PIPELINES
Size Specific Tools

10" to 24" Tool Kit

Clamps: $3,590,000
Running tools:$470,000

Total: $4,060,000

DW RUPE FLOWLINES
Size Specific Tools – 15,000 psi rated

2 ea 10" MAX 14 assy. (FMC): $197,800
4", 5", 6", 7", 8" Inner Bodies: $332,800
Running Tools: Rental
Pipe Lift Tools: Rental
48 pipe bends: $15,000
Miscellaneous piping: Free issued by participants

Total: $604,200

Figure 9.5 – Overall Cost Breakdown

10.0 PATH FORWARD – PROJECT EXECUTION PLAN OUTLINE

Phase 2A is currently scheduled to start by the end of June (pre-sanction phase), and the test program (post sanction phase) by September 1, 2005. The last DW RUPE meeting by June 9, 2005 established a tentative date for completion of phase 2B by December 2006. The current schedules are based on that target, and on QCS indicated 28 week manufacturing cycles. The combined schedules for phases 2A and 2B (DW RUPE PL) show a December completion is possible, provided raw materials are "pre-approved" approximately one month prior to the actual production runs. The production runs have been divided into two batches, where the first batch will consist of one additional 12", plus 2 each of the 10",14"and 16", and the second batch would be 2 each of the 18" and 24" clamps. The current plan uses the

Oceaneering delivery schedule for the lift frame, FBE removal tool and cutting tool as reference.

10.1 DW RUPE PL Combined Phases 2A and 2B

Appendix 6 shows the overall project schedule for the combined phases, in addition to a detailed test program and typical 28 week clamp production cycle. This schedule also shows an overview of the DW RUPE FL program, which is based on FMC's production cycle of 24 weeks and ex-works Houston TX delivery. The pipe pieces are assumed as free issue from the participants, and the production for induction bends is 4 weeks, including the transportation of free issued pipe to the BENDCO facility in Houston, TX.

11.0 REFERENCES

Ref #	Description
1	Deep Water Rupe – Design Basis Document, SSI # 221021-PL-DB-0001 Rev. B
2	Request for Information Document, dated January 31, 2005
3	Request for Quote Package
4	Detailed Cost Breakdown
5	DW RUPE PL Phase 2A Cost Breakdown
6	DW RUPE PL Phase 2B Cost Breakdown
7	DW RUPE FL Phase 2B Cost Breakdown
8	Background information – QCS Proposal (Structural Clamps)
9	Background Information – FMC Proposal (Mechanical Collet Connectors)
10	Background Information – Bendco quote (Induction Bends)

12.0 APPENDIX 1 – FAILURE MODE AND EFFECTS ANALYSIS

FMECA Report	**Equipment:**	**Deep Water Pipelines and Flowlines in the Gulf of Mexico**	
Rev.: D	**Phase:**	**All**	

Phase	Potential Failure Mode(s)	Potential Cause(s) of Failure	Risk Priority Index
Operation	Wet Buckle	Anchor Snag	450
Operation	Dry Buckle	Anchor Snag	360
Hydrostatic Test	Weld crack Base metal crack Crack <= 1 x OD	Improper Installation Parameters Monitoring, exceeding allowable stress limits	210
Hydrostatic Test	Weld crack Base metal crack Crack <= 1 x OD	Improper Installation Engineering	210
Hydrostatic Test	Weld crack Base metal crack Crack <= 1 x OD	Bad Weather, fail to predict or follow weather reports	210
Hydrostatic Test	Weld crack Base metal crack Crack <= 1 x OD	Lay Vessel Loss of Dynamic Positioning	210
Operation	Dry Buckle	Thermal Buckling	160
Hydrostatic Test	Inline Equipment leaks (PLETS, PLEMS, Valves, WYES, etc.)	Improper or no factory acceptance tests, damage during transport or installation	140
Operation	Wet Buckle	Dropped Object Near Platform	120
Hydrostatic Test	Pinhole Leak (for Hydrostatic Tests Conducted during the service life, e.g. after a repair is performed)	Corrosion	105
Operation	Wet Buckle	Dropped Object Away from Platform	100
Operation	Wet Buckle	Thermal Buckling	100
Operation	Dry Buckle	Dropped Object Near Platform	96
Operation	Rupture	Mudslide Break(e.g. near Mississippi Canyon Area)	90
Operation	Plugging	Paraffin Accumulation	90
Installation	Pipe drop to seabed	Lay Equipment Failure	81
Operation	Dry Buckle	Dropped Object Away from Platform	80
Operation	Inline Equipment Leak	Inline equipment failure: Seal Failure on valves, flanged closures, test ports, etc. Due to material aging, vibration, etc. Applies to inline valves, PLETS, PLEMS, Manifolds, Subsea pig launchers, etc.	72
Installation	Wet Buckle	Improper Installation Parameters Monitoring	64
Installation	Wet Buckle	Improper Installation Engineering	64
Operation	Dent	Dropped Object near platform	63
Hydrostatic Test	Wrinkles due to improper installation	Improper Installation Parameters Monitoring, exceeding allowable stress limits	63
Hydrostatic Test	Wrinkles due to improper installation	Improper Installation Engineering	63
Operation	Dent	Dropped Object Away from Platform	56
Operation	Plugging	Hydrate Formation	56
Installation	Dry Buckle	Improper Installation Parameters Monitoring	56
Installation	Dry Buckle	Improper Installation Engineering	56
Installation	Wet Buckle	Bad Weather, fail to predict or follow weather reports	48
Hydrostatic Test	Weld crack Base metal crack Crack > 1 x OD	Improper Installation Parameters Monitoring, exceeding allowable stress limits	42

FMEA Criticality Analysis Index Codes

Severity Index

Severity	Criteria	Ranking
Hazardous	Hazardous effect. Safety related. Sudden failure. Noncompliance with government regulations.	10
Serious	Potential hazardous effect. Able to stop product/service without mishap. Safety related. Time-dependent failure. Disruption to subsequent process operations. Compliance with government regulation is in jeopardy.	9
Extreme	Customer very dissatisfied. Extreme effect on process/service; equipment damaged. Product/service incomplete but safe.	8
Major	Customer dissatisfied. Major effect on service; rework on service necessary. Product/service performance severely affected but functionable and safe.	7
Significant	Customer experiences discomfort. Product/process performance degraded, but operable and safe.	6
Moderate	Customer experiences some dissatisfaction. Moderate effect on product or service performance.	5
Minor	Customer experiences minor nuisance. Minor effect on product or service performance. Fault does not require attention.	4
Slight	Customer slightly annoyed. Slight effect on product or service performance.	3
Very slight	Customer more likely will not notice the failure. Very slight effect on product / process performance.	2
No	No discernible effect on product or subsequent processes.	1

FMEA Criticality Analysis Index Codes

Occurrence Index

Occurrence	Criteria	Ranking
Almost Certain	Failure almost certain.	10
Very High	Very high number of failures likely.	9
High	High number of failures likely.	8
Moderately High	Frequent high number of failures likely.	7
Medium	Moderate number of failures likely.	6
Occasional	Occasional number of failures likely.	5
Slight	Few failures likely.	4
Very slight	Very few failures likely.	3
Rare	Rare number of failures likely.	2
Unlikely	Failure unlikely. History shows no failures.	1

FMEA Criticality Analysis Index Codes

Detection Index

Detection	Criteria	Ranking
Almost Impossible	Absolute certainty of non-detection.	10
Very Remote	Very remote likelihood current controls will detect failure.	9
Remote	Remote likelihood current controls will detect failure.	8
Very Low	Very low likelihood current controls will detect failure.	7
Low	Low likelihood current controls will detect failure.	6
Moderate	Medium likelihood current controls will detect failure.	5
Moderately High	Moderately high likelihood current controls will detect the failure.	4
High	High likelihood current controls will detect failure.	3
Very High	Current controls will almost always will detect failure.	2
Certain	Current controls certain to detect.	1

13.0 APPENDIX 2 - REQUESTS FOR INFORMATION

DW RUPE

REQUEST FOR INFORMATION - SCOPE OF SUPPLY

Summary Of Request:

Further to our discussions, DW RUPE wishes to make an evaluation of repair system components (subsystems) that you recommend and wish to supply to DW RUPE for affecting deepwater pipeline repairs. Of interest are equipment/tools and installation means (ROVs & Vessels) to perform:

a. **Surface Lift and on-bottom connections**
b. **Spool Piece repairs on-bottom**
c. **Clamp Repairs on- bottom**
d. **Temporary "Band-Aid" repairs on-bottom**

For pipes sized from 4 to 24 inches in diameter and water depths from 1000 to 10,000 fsw, and pressure rating to ANSI 1,500.

Our quest is Low CAPEX solutions that you would recommend to us. Please refer to our Design Basis Document for detailed requirements.

We need to know your company's intention to supply a cost quote based on the information you provide below:

Group I – Generic Tools

Pollution Control System Yes No

Type: ______________________________

Pipe Lift Frames Yes No

Type: ______________________________

Pipe Cutting System Yes No

Type: ______________________________

End Preparation Tool Yes No

Type: ______________________________

On-Bottom FBE and Weld Seam Removal Tool Yes No

Type: ______________________________

Pipe Plug and Lift Tool **Yes** **No**

Type: ____

Pipe Measurement System **Yes** **No**

Type: ____

Pipe Leak Location System **Yes** **No**

Number ___

Type: ____

Group II - Clamps

Structural Repair Clamp **Yes** **No**

Type: ____

Non-Structural Repair Clamp **Yes** **No**

Type: ____

Group III – On Bottom Spool Piece Repair System

In-Line Connection **Yes** **No**

Number of Connections per repair ___

Type Products:

____

____

Jumper Connection **Yes** **No**

Number of Connections per repair ___
Type Products:

____

____

In-Line with Flex Loop Optional **Yes** **No**

Number of Connections per repair___
Type Products:

____

____

Group IV – Temporary Repair

Band-Aid Temporary Repair System **Yes** **No**

Number ___

Type: ____

Group V – Survey and Construction Services

ROV <u>Services</u> **Yes** **No**

Number ___

Type: ____

DP Work Vessel Services (On-Bottom work) **Yes** **No**

Number ___

Type: ____

DP Pipe Lift/Lay Vessel Services **Yes** **No**

Number ___

Type: ____

14.0 APPENDIX 3 - REQUESTS FOR QUOTES

STRESS SUBSEA, INC.
HOUSTON, TEXAS

DEEP WATER RUPE
REQUEST FOR QUOTATION

			Doc. No.: 221006b-PC-SP-0001			
Rev. No.	**Rev. Date**	**Revision Description**	**Prep. By:**	**Stress Subsea Checked**	**Stress Subsea Approved**	
A	9-22-04	Draft	AR	WLA	RRA	

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Page No.

PART 1 - TECHNICAL

1.0 INTRODUCTION

This Request for Quotation (RFQ) addresses the equipment to be purchased by the Deep Water Response to Underwater Emergencies project (DW RUPE), which aims at developing a low CAPEX pipeline/flowline repair capability in water depths in the 1000-10,000 ft range, in the Gulf of Mexico.

1.1 DEFINITIONS

The following definitions apply to this RFQ:

Engineer Stress Subsea, Inc.

Subcontractor Company selected to bid on materials and services, as specified in this RFQ

Clamp Repair Method A permanent repair method involving the use of an external diverless split clamp with elastomeric seals.

Major Damage, Long A damage that affects a length of more than 240 ft (6 joints of pipe).

Major Damage, short A damage that affects a length of less than 240 ft.

Minor Damage A damage of less than a pipe diameter in size which does not compromise the structural integrity of the pipe.

On bottom Repair Method A permanent repair method that does not require lifting the pipe to the surface, or the use of a heavy lift vessel. The on-bottom repair utilizes a combination of special connectors, sleds and jumpers. The replacement pipe section can be either a fully horizontal spool piece, or the pipe section can be a vertical "jumper", or other.

Pinhole Leak Damage A type of minor damage for which a non structural clamp would be used.

Pipe Plug and Lift Tool A diverless device which is installed in the ID of the pipe and can be used to lift a pipe to the surface.

Pipe Throughout this document, "Pipe" means either an export pipeline or an infield or tieback flowline, insulated or non-insulated, plain pipe or pipe-in-pipe.

Surface Lift Repair Method A permanent repair method that involves the use of either a general-purpose offshore vessel or a pipelay vessel capable of heavy lifting. In this case the cut pipe ends are individually lifted to the surface to add pipe and weld on an end connector. The pipe ends are subsequently aligned and connected on bottom using diverless techniques.

Structural Repair Clamp A diverless split clamp with radial and longitudinal seals, used when the pipe to be repaired has sustained structural damage. The Structural Repair Clamp is a permanent repair.

Non-Structural Repair Clamp A diverless split clamp with radial and longitudinal seals, used when the pipe to be repaired has sustained a pinhole leak damage. The Non-Structural Repair Clamp is a permanent repair.

Pollution Control System Some method of minimizing pollution during repairs may be offered, e.g. underwater "tents", collection bags, pipe lift to create seawater hydraulic locking of oil residues within the pipe, etc.

Weld Neck Flanges Weld neck flanges are used with the surface lift repair method.

These flanges are *not* part of the current scope of supply

Pipe Lift Frames	Pipe Lift Frames are reusable ancillary components used to lift and position the pipe to be repaired. The frames can move the pipe vertically and laterally for alignment.
End Preparation Tool	An ROV operated tool to clean burrs and ragged edges resulting from the cutting operation, so that end connectors can be installed subsea.
External Coat and Weld Seam Removal Tool	Some connection systems require that the pipe end receiving the connector should be cleaned of any external coatings such as Concrete, Hard Insulation, FBE and, if the pipe construction is seam welded, the weld crown shall be machined flat. Typically, this tool is deployed using an ROV.
Diverless Hydraulic End Connectors	Diverless hydraulic end connectors can be used as part of a subsurface repair method. In the case of surface repair, they can be mounted as a pull-head assemblies or as a permanent part of the repair.
Gantry Sled	The Gantry Sled consists of a lower frame with mud mats, which is used to support end connectors, and a removable upper frame, used for the connection operations. The lower frame becomes a permanent part of the pipe repair.
Pipe Measurement System	A measurement system to measure the gap and flange face alignment between the prepared pipe ends so that the jumper or spool piece can be adjusted to the proper length for mating. The known systems are a mechanical system and a hydroaccoustic system.
Jumper or Spool Piece Assembly	The “vertical” jumper assembly is typically made of two female collet connectors linked by a piece of pipe that has been shaped to

various forms. The shape and length of the pipe jumper will vary with the predicted loads and displacements required (e.g. due to thermal expansion, etc.). Alternatively an in-line Spool Piece can be deployed, depending on alignment requirements.

On Bottom Spool Repair	A repair that uses spool pieces. The shape of the spool pieces (straight or jumper style) are dictated by project specific requirements such as loads and displacements (e.g. thermal expansion).
In Line Spool Piece	An alternate method for on-bottom repair. The selection of this method is a function of factors such as alignment requirements, loads and displacements. An optional horizontal loop may be used if thermal expansion is of concern.
Jumper Spool Piece	Case in which the spool is not straight, its geometry consisting of vertical or horizontal bends to increase in-line flexibility in order to ease the connection process
Temporary Repair Method	A temporary, "Band Aid" repair, is a new concept, created to allow a damaged pipe to safely return to production for a short period of time (say 180 days), while the mobilization of resources for the permanent repairs are under way.

1.2 SCOPE OF WORK

1.2.1 General

Subcontractor shall furnish all labor, materials, supervision, facilities, and equipment required to engineer, manufacture and test the equipment listed in this RFQ. All equipment supplied shall meet the functional requirements defined herein.

1.2.2 Overview

The DW RUPE includes 4, 5, 6, 7, 8, 9, 10, 12, 16, 18 and 24-inch nominal pipe sizes.

The repair strategy divides the repair systems into two subsets, as follows:

- **System A**: Small diameter, high pressure flowlines in the 4-inch to 10-inch nominal diameter range will be designed for ANSI 2500 pressure class. Since there is a number of vessels in the Gulf of Mexico capable of lifting these sizes, this system will likely use the **Surface Lift Method**.
- **System B**: Large diameter flowlines and pipelines in the 12-inch to 24-inch nominal diameter range will be designed for ANSI 1500 pressure class. The large diameter pipes are far more complex to lift and surface repair, thus **On Bottom Repair Methods** are more likely.

Subcontractor may offer either a single or a set of separate solutions for "A" and "B" systems, based on practical and economical (low CAPEX) considerations.

1.2.3 Quantities

Table 3.3-1 defines the base case quantities required by the DW RUPE project. Subcontractor's quote may differ from the base case quantities, as a function of a particular design, or usage of the same tool for multiple sizes, *as long as all required sizes are covered by the bid.*

<table>
<tr><th>Group</th><th>Group Description</th><th>Description</th><th>Qty</th><th>Notes</th></tr>
<tr><td rowspan="4">I</td><td rowspan="4">Generic Tools</td><td>Pipe Lift Frames w/ vertical and lateral movement for 4-10-inch sizes.</td><td>2</td><td></td></tr>
<tr><td>Pipe Lift Frames w/ vertical and lateral movement for 12-24-inch sizes.</td><td>2</td><td></td></tr>
<tr><td>Pipe Plug and Lift Tool.</td><td>11</td><td></td></tr>
<tr><td>Pipe Measurement System</td><td>1</td><td></td></tr>
<tr><td rowspan="4">II</td><td rowspan="4">Clamps</td><td>Structural Repair Clamps for 4-10-inch</td><td>7</td><td>ANSI 2500 Rated</td></tr>
<tr><td>Non Structural Repair Clamps for 4-10-inch</td><td>7</td><td>ANSI 2500 Rated</td></tr>
<tr><td>Structural Repair Clamps for 12-24-inch</td><td>4</td><td>ANSI 1500 Rated</td></tr>
<tr><td>Non Structural Repair Clamps for 12-24-inch</td><td>4</td><td>ANSI 1500 Rated</td></tr>
<tr><td rowspan="4">III</td><td rowspan="4">On Bottom Spool Piece Repair System</td><td>In-line Connection System w/optional Horizontal Flex Loop for 4-10-inch</td><td>7</td><td>ANSI 2500 Rated</td></tr>
<tr><td>In-line Connection System w/optional Horizontal Flex Loop for 12-24-inch</td><td>4</td><td>ANSI 1500 Rated</td></tr>
<tr><td>Vertical Jumper Connection System for 4-10-inch</td><td>7</td><td>ANSI 2500 Rated</td></tr>
<tr><td>Vertical Jumper Connection System for 12-24-inch</td><td>4</td><td>ANSI 1500 Rated</td></tr>
<tr><td rowspan="2">IV</td><td rowspan="2">Temporary Repair</td><td>Band-Aid Temporary Repair System for 4-10-inch</td><td>7</td><td>ANSI 900</td></tr>
<tr><td>Band-Aid Temporary Repair System for 12-24-inch</td><td>4</td><td>ANSI 900</td></tr>
</table>

1.3 ASSUMPTIONS

1.3.1 Insulation Repair

The repair of missing insulation is assumed as a simple diverless “insulating mattress” deployment, to cover the damaged area and, to some extent, prevent direct convection.

1.3.2 Pigging Capability

The repair system to be developed will permit normal pipe cleaning pigs (spheres, scrapers and intelligent pigs). The minimum bend radius of any repair component shall be of 3 x OD.

1.3.3 Concrete Coating Repair

Repair to the concrete coat will be done by lowering a concrete mattress over the damaged section. DW RUPE will not cover this type of repair.

1.4 DESIGN CRITERIA, CODES AND REGULATIONS

1.4.1 General

All components that are to be a permanent part of the repair shall be analyzed using the codes and recommended practices set forth in this RFQ Document.

1.4.2 Codes

Components that are part of a permanent repair shall meet the allowable stress limits set forth in ASME B31.4 and ASME B31.8. Other codes include ASME Pressure Vessel Code, Section III, Division 2.

Pipe Pressure Rating will be determined in accordance with ASME B16.5, Pipe Flanges and Flanged Fittings.

Line Pipe will be specified per API 5L, Specification for Line Pipe.

Diverless Systems will be specified per ISO 13628-8:2002 – 1st Edition – Remotely Operated Vehicle (ROV) Interfaces on Subsea Production Systems.

1.4.3 Recommended Practices

Pipe design for collapse shall be in accordance with API 1111. Testing is covered in API Specification 6D and 6H.

The size of mud mats shall be in accordance with API RP 2A WSD.

Other Recommended Practices may be identified during the work performed.

1.4.4 Design Life

The required design life for any repair system is 20 years

1.5 ENVIRONMENTAL DATA

1.5.1 Water Depth

The minimum water depth for all repair systems is 1000 ft. The maximum water shall not exceed 10,000 ft.

1.5.2 Current

The effects of current will be neglected during the first phase of the DW RUPE.

1.5.3 Seabed Mechanic Properties

The soil property of interest is the surface shear strength. The minimum shear strength to be considered is 45 psf.

1.5.4 On Bottom Temperature

The temperature is assumed to be 34°.

PART 2 – INSTRUCTIONS TO BIDDERS

2.0 GENERAL

2.1.1 Bid Acknowledgement Form

Subcontractor shall send a bid acknowledgement form via email (ray.ayers@stress.com) or fax (281-890-6138).

2.1.2 Conflicts and Contradictions

In case there is a conflict or contradiction between specifications or portions of this RFQ, Subcontractor shall contact Engineer and a decision will be made by Engineer as to which requirement shall govern.

2.1.3 Bid Validity

The original quotes shall be valid for a period of thirty (30) days from the bid due date specified in the cover letter. After the initial period, prices shall be adjusted in accordance to the Producer Price Index (PPI), series WPU10, Group: Metals and Metal Products, Item: Metals and Metal Products. For further information on the PPI, please consult http://www.bls.gov/data/home.htm.

2.1.4 Pricing

Pricing shall be inclusive of all engineering, R&D, Qualification tests, and Project Management. Delivery shall be (INCOTERMS 2000) CFR TBD location in Houston, TX, USA.

Subcontractor shall quote unit rate prices for all materials and services to be used for additional material requirements, spares and extra work.

Price quoted shall be in US Dollars.

2.1.5 Right to Award or Reject

Engineer reserves the right to award to other than the low bidder and to reject any or all of any bid(s).

2.1.6 Questions

Questions shall be directed in writing to ray.ayers@stress.com or armando.rebello@stress.com, fax # 281-890-6138. It is the Subcontractor's responsibility to review all documentation for completeness and clarity and inform Engineer, prior to Bid submittal, of any additional requirements or explanations.

2.1.7 Content

The following information shall be provided, in labeled attachments to Subcontractor's bid package:

- Price form as provided in the attachment
- A technical description of each line item being quoted
- Subcontractor's Experience in manufacturing similar products, including sizes, pressure ratings, water depth, etc.
- A level xxx schedule with engineering, testing, qualification, manufacturing, FAT's and delivery steps.
- A description of Subcontractor's facilities to be employed during the project
- A description of Subcontractor's Quality System
- A statement of Safety Record
- Any and all technical exceptions to the RFQ document.

2.1.8 Submittal

Bid response shall be submitted and must bear RFQ Number as spacified in the cover letter, and "SEALED BID – TO BE OPENED BY ADDRESSEE ONLY" on the outside of the package. The bid response shall be submitted to the address below:

Stress Subsea, Inc.
13603 Westland East Blvd.
Houston, Texas 77041-1208

Attn.: Ray Ayers, Ph.D, P.E.

2.1.9 Evaluation

Subcontractor is informed that Engineer's evaluation of the bid responses will include but not be limited to the following areas to be included in the Subcontractor's submittal:

- Price
- Equipment suitability for the intended service
- Delivery Schedule
- Subcontractor's Quality System
- Manufacturing Facilities and Available Capacity
- Technical Exceptions

PART 3 – BID ACNOWLEDGEMENT FORM

3.0 BID ACKNOWLEDGEMENT

(Subcontractor shall complete this form, and return, via facsimile to the below address, within four working days of receipt)

DEEP WATER RUPE
Request for Quotation
Supply of Deep Water Repair Equipment

To: Stress Subsea, Inc.
13603 Westland East Blvd.
Houston, TX 77041-1206

Attn.: Ray Ayers, Ph.D, P.E.

We,__________________________________(company name) certify that we have received the above referred RFQ, and intend to submit a bid by the date requested.

-or-

We,__________________________________(company name) certify that we have received the above referred RFQ, and have determined that at this time, we are not in a position to submit a bid for this work. Your RFQ will be returned to the above address, as requested.

By:____

Title:____

PART 4 – CONTACT INFORMATION

4.0 CONTACT INFORMATION

Subcontractor shall state the proposed **Commercial Contact** for this contract:

Name: ____

Title:____

Telephone:_____________________________________

Email Address:__________________________________

Subcontractor shall state the proposed **Technical Contact** for this contract:

Name: ____

Title:____

Telephone:_____________________________________

Email Address:__________________________________

PART 5 – QUOTE FORM

5.0 QUOTE FORM

Please see the attached MS Excel Spreadsheet.

15.0 APPENDIX 4 – COLLET CONNECTOR PROPOSAL

FMC Technologies

FMC Budgetary Proposal Number 05B-1262 Rev. B
Stress Subsea Connectors

Subsea Systems
1777 Gears Road
Houston, TX 77067
TEL (281) 591-4000

June 10, 2005 BUDGETARY PROPOSAL

COMPANY: Stress Subsea, Inc.

PROPOSAL: 05B-1262 Rev. B

ATTENTION: Armando Rebello, P.E.

e-mail:

FROM: Robert Coffman

SUBJECT: 4" to 10" Collet Connectors & Hubs – Budgetary Proposal

CC: Randy Wester, Brian Yates, Steve Feldman

Further to our earlier budgetary quotations 05B-1262 and 05B-1262 Rev. A for Stress Subsea's DWRUPE JIP, FMC Technologies is pleased to offer the following revised budgetary quotation 05B-1262 Rev. B for mechanical connectors and matching hub assemblies.

Rev B option scope as follows:	**Qty.**	**Unit Price**	**Total Price**
1. **For 10" nominal (9.5" bore), 15ksi:**			
MAX 14 connector assembly, matching hub, and two gaskets EE trim, fully assembled and tested	2	$98,900	$197,800
===			
2. **For 8" nominal (6.725" bore), 10ksi:**			
MAX 8 connector inner body, matching hub and two gaskets, EE trim	2	$34,000	$68,000
3. **For 7" nominal (5.75" bore), 15ksi:**			
MAX 8 connector inner body, matching hub and two gaskets, EE trim	2	$33,600	$67,200
4. **For 6" nominal (5.313" bore), 15ksi:**			
MAX 8 connector inner body, matching hub and two gaskets, EE trim	2	$33,200	$66,400
5. **For 5" nominal (4.063" bore), 15ksi:**			
MAX 8 connector inner body, matching hub and two gaskets, EE trim	2	$32,800	$65,600
6. **For 4" nominal (3.826" bore), 15ksi:**			
MAX 8 connector inner body, matching hub and two gaskets, EE trim	2	$32,800	$65,600

===

Subsea Systems
1777 Gears Road
Houston, TX 77067
TEL (281) 591-4000

7. **Remaining parts to allow for the full completion of any pair of MAX 8 connector assemblies per (Items 2 – 6 above):**

Full connector assy and hub support structure, (less inner body, hub and two gaskets)	2	$27,000	$54,000

8. **Assembly of any pair of MAX 8 connector assemblies (includes setting of hump pressure)**

	2	$3,300	$6,600

Clarifications:

1. Prices are non-binding budgetary +/- 20%.
2. As agreed, the 8” nominal (6.725” bore) MAX 8 connector size is rated at 10ksi w.p. All other connector sizes are rated at 15ksi w.p.
3. Service people and fabrication/ installation tools: such as pressure caps; test stands; fabrication stands; spreader bars, etc have not been included in this bid.
4. Delivery for connectors and hubs is ex-Works and is estimated at 24 weeks.
5. Delivery for assembly and setting of hump pressure for two MAX 8 connectors - 1 week after PO and requirements are defined.
6. The use of mechanical connectors is subject to the availability of Connector Actuation Tools (CAT’s).
7. FMC Terms and Conditions would apply. Terms and Conditions available upon request.

16.0 APPENDIX 5 – INDUCTION BEND PROPOSAL

BENDCO

BUS: (713) 473-1557
FAX: (713) 473-1882

HOUSTON OPERATIONS
801 HOUSTON AVE
PASADENA, TX 77502

COMPANY: STRESS SUBSEA INC.

NAME: ARMANDO REBELLO

TELEPHONE: 281-890-0305

FAX NO: 281-890-6138

ADDRESS:

BENDCO NO.:

DATE QUOTED: 06/21/05 BY: J. NEAL

P.O. NO.:

PAYMENT C.O.D. [X] LABOR & MAT'L [ ]

CREDIT [ ] LABOR ONLY [X]

FREIGHT COLLECT [ ] FREIGHT PAID [ ]

CARRIER: WILL CALL

ITEM	QTY	DESCRIPTION	LABOR	MAT'L	UNIT	LINE
1	8	4" ES A106 ROLLED 90° 3D RADIUS	X		175.00	1,400.00
		INDUCTION BEND				
2	8	5" XXS A106 ROLLED 90° 3D RADIUS	X		325.00	2,600.00
		INDUCTION BEND				
3	8	6" ES A106 ROLLED 90° 3D RADIUS	X		325.00	2,600.00
		INDUCTION BEND	X			
4	8	7" ES A106 ROLLED 90° 3D RADIUS			425.00	3,400.00
		INDUCTION BEND				
5	8	8" ES A106 ROLLED 90° 3D RADIUS	X		575.00	4,600.00
		INDUCTION BEND				
6	8	10" ES A106 ROLLED 90° 3D RADIUS	X		625.00	5,000.00
		INDUCTION BEND				
		MINIMUM TANGENTS				
		NO TRIM ,NO BEVEL				
		NO HEAT TREAT				
		FOB BENDCO				

F.O.B. BENDCO

ESTIMATED DELIVERY ONLY: 2-3 WKS ARM

TOTAL $19,600.00

All delivery dates are based on current shop load and will be subject to review at the time of order placement.

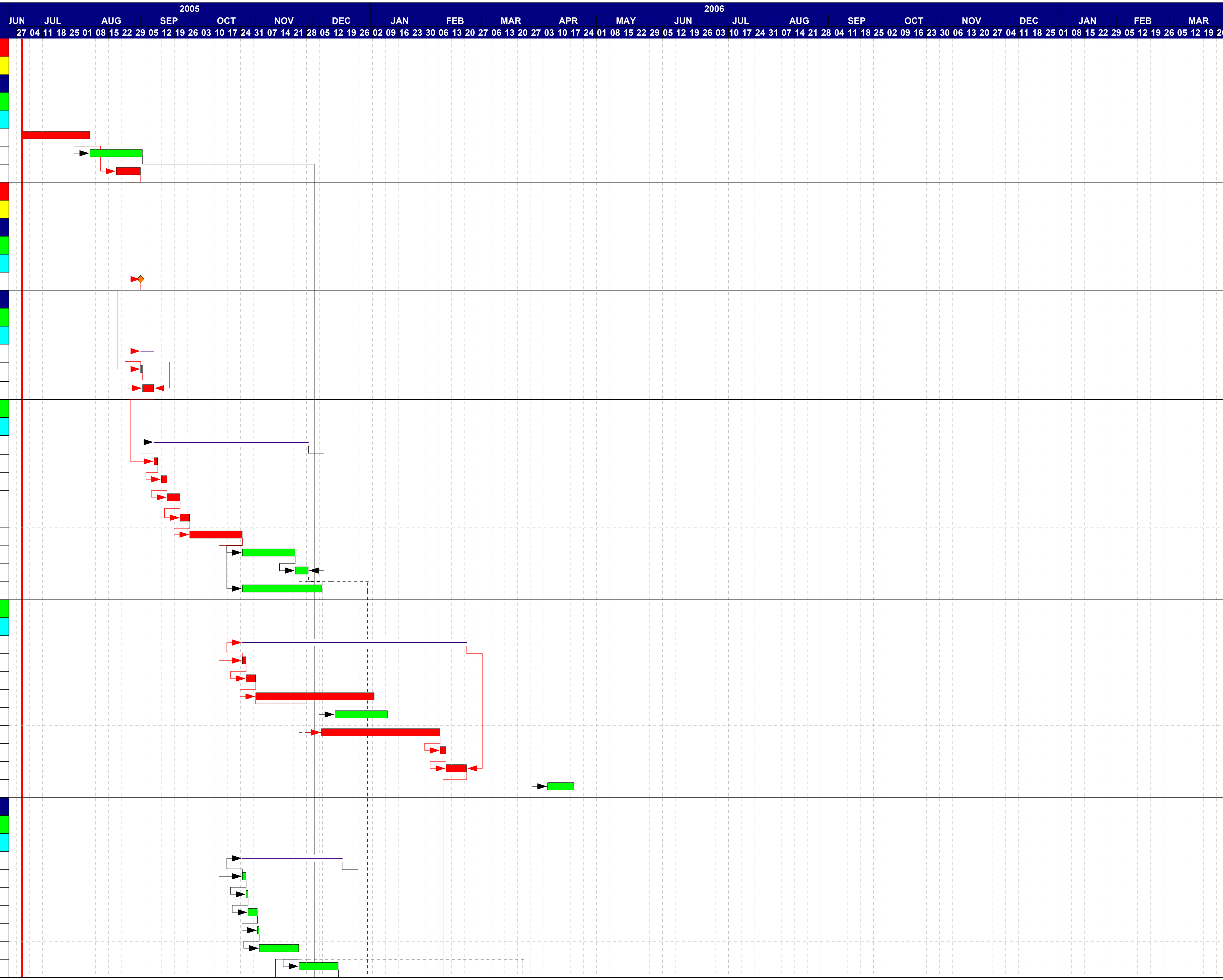
TERMS; 1ST ORDER IS C.O.D. - A RESALE CERTIFICATE (IF APPLICABLE) MUST BE FURNISHED WITH FIRST ORDER. CREDIT INFORMATION MUST BE FURNISHED IN A TIMELY MANNER TO ESTABLISH A NET 30 DAY ACCOUNT FOR THE SECOND ORDER.

ASME CODE CERTIFIED

SUBJECT TO BENDCO'S STANDARD TERMS & CONDITIONS (FAXED UPON REQUEST).

17.0 APPENDIX 6 – PHASE 2A AND 2B – COMBINED SCHEDULE

Description	Orig Dur	Early Start	Early Finish
Pre-Sanction			
Phase 1 Completion			
Develop Phase 2 Design Basis	25	30JUN05 A	04AUG05
Prepare Phase 2A Test Specification	20	05AUG05	01SEP05
Prepare & Issue PO for 12-Inch Prototype Clamp	9	19AUG05	31AUG05
Phase 2			
Phase 2A			
Phase 2A Kick-Off			
Phase 2A Kick-Off	0	01SEP05	
12-Inch Prototype Clamp			
Contract			
QCS Contract Review	5 *	01SEP05	07SEP05
QCS Pre-Award Meeting	1	01SEP05	01SEP05
QCS Commercial & Technical Review	4	02SEP05	07SEP05
Clamp Engineering			
QCS 12-Inch Prototype Clamp Engineering	58 *	08SEP05	28NOV05
Clamp - Tech Scope Definition	2	08SEP05	09SEP05
Clamp - Design Parameter Development	3	12SEP05	14SEP05
Clamp - Concept Development	5	15SEP05	21SEP05
Clamp - Evaluation / Selection	3	22SEP05	26SEP05
Clamp - Engineering	20	27SEP05	24OCT05
Clamp - Drafting	20	25OCT05	21NOV05
Clamp - Drafting Revision	5	22NOV05	28NOV05
Clamp - SSI Design Review	30	25OCT05	05DEC05
Clamp Procurement & Mfg.			
QCS 12-Inch Prototype Clamp Proc. & Mfg.	85 *	25OCT05	20FEB06
Clamp - RFQ Development	2	25OCT05	26OCT05
Clamp - RFQ Response	3	27OCT05	31OCT05
Clamp - Purchase Raw Materials	45	01NOV05	02JAN06
Clamp - Purchase Ancillaries	20	13DEC05	09JAN06
Clamp - Machining	45	06DEC05	06FEB06
Clamp - Inspect & Prelim. Assembly	3	07FEB06	09FEB06
Clamp - Coat	7	10FEB06	20FEB06
Clamp - Refurbish and Store for Offshore	10	05APR06	18APR06
12-Inch Prototype Running Tool			
Running Tool Engineering			
QCS 12-Inch Prototype Engineering	39 *	25OCT05	16DEC05
Running Tool - Tech Scope Definition	2	25OCT05	26OCT05
Running Tool - Design Parameter Development	1	27OCT05	27OCT05
Running Tool - Concept Development	3	28OCT05	01NOV05
Running Tool - Evaluation / Selection	1	02NOV05	02NOV05
Running Tool - Engineering	15	03NOV05	23NOV05
Running Tool - Drafting	15	24NOV05	14DEC05

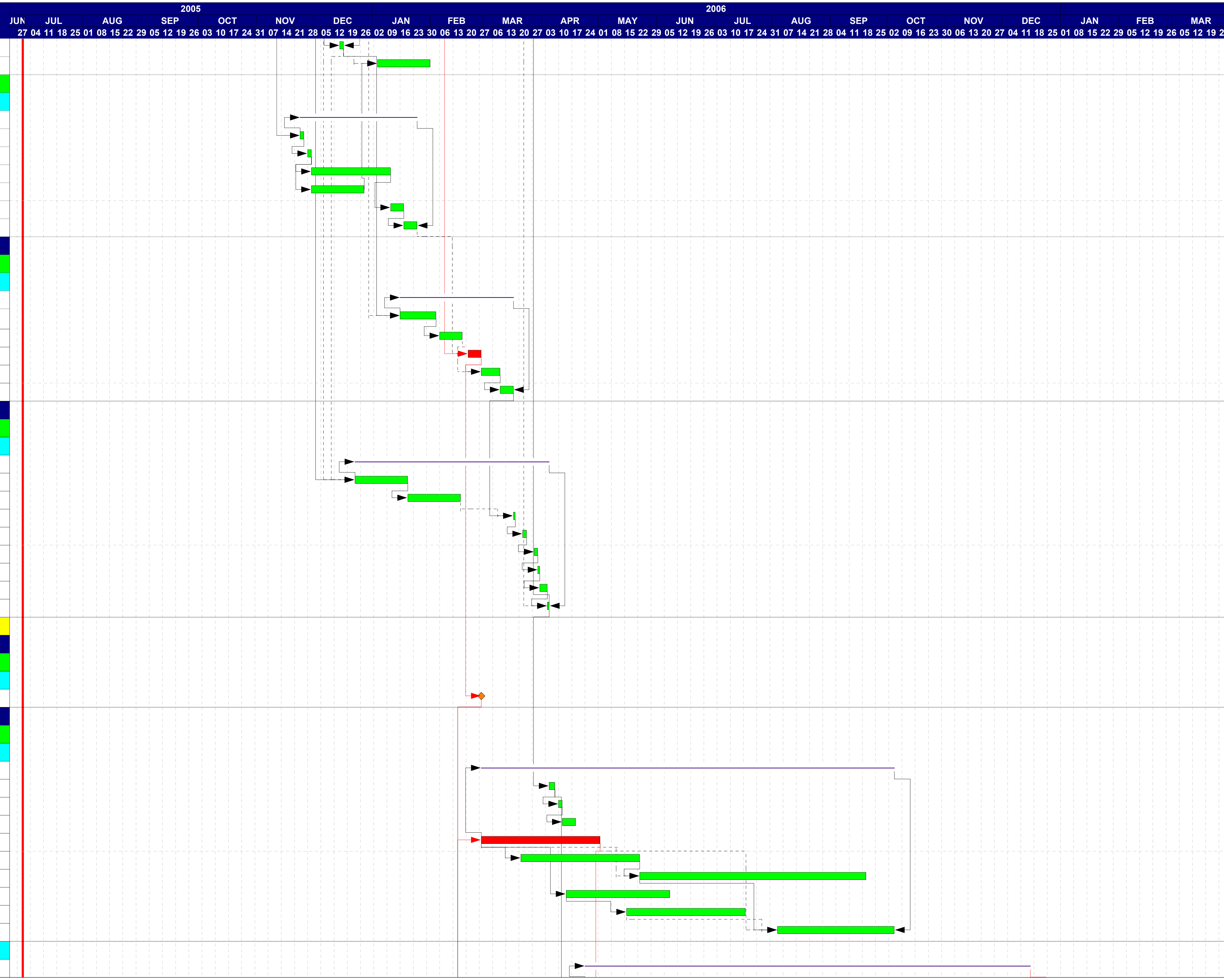


Start date	30JUN05
Finish date	15DEC06
Data date	30JUN05
Run date	07JUL05
Page number	1A

Stress Subsea, Inc.
DW RUPE Phase 2

- Early bar
- Progress bar
- Critical bar
- Summary bar
- Start milestone point
- Finish milestone point

Description	Orig Dur	Early Start	Early Finish
Running Tool - Revision	2	15DEC05	16DEC05
Running Tool - Machining	20	04JAN06	31JAN06
Running Tool Procurement & Mfg.			
QCS Running Tool - Procurement &	44 *	24NOV05	24JAN06
Running Tool - RFQ Development	2	24NOV05	25NOV05
Running Tool - RFQ Response	2	28NOV05	29NOV05
Running Tool - Purchase Ancillaries	30	30NOV05	10JAN06
Running Tool - Purchase Raw Materials	20	30NOV05	27DEC05
Running Tool - Inspect & Prelim. Assembly	5	11JAN06	17JAN06
Running Tool - Coat	5	18JAN06	24JAN06
12-Inch Prototype Integration & FAT			
QCS 12-Inch Prototype Integration & FAT	44 *	16JAN06	16MAR06
Integration Procedure Development	15	16JAN06	03FEB06
Integration Testing Development	10	06FEB06	17FEB06
Final Assembly	5	21FEB06	27FEB06
Functional Testing	8	28FEB06	09MAR06
SIT Prep	5	10MAR06	16MAR06
12-Inch Prototype Component & SIT			
Component & SIT Testing	73 *	23DEC05	04APR06
Test Apparatus - Design	20	23DEC05	19JAN06
Test Apparatus - Procure and Fabricate	20	20JAN06	16FEB06
Conduct Torsion Test	1	17MAR06	17MAR06
Conduct Compression Test	2	22MAR06	23MAR06
Conduct Bending Test	2	28MAR06	29MAR06
Conduct Clamp on FBE Test	1	30MAR06	30MAR06
Conduct Ovalization Test	2	31MAR06	03APR06
Conduct SIT	1	04APR06	04APR06
Phase 2B			
Phase 2B Kick-Off			
Phase 2B Kick-Off	0	28FEB06	
Pipeline			
Size Specific Repair Tools			
Pipeline 10-Inch to 16-Inch			
Pipeline Repair Tool 10-Inch to 16-Inch	156 *	28FEB06	04OCT06
Update Performance Spec.	3	05APR06	07APR06
Update RFQ	2	10APR06	11APR06
RFQ Response & Issue PO	5	12APR06	18APR06
QCS Clamp Engineering	45	28FEB06	01MAY06
QCS Purchase Raw Materials	45	21MAR06	22MAY06
QCS Clamp Procurement & Mfg.	85	23MAY06	19SEP06
QCS Running Tool Engineering (10-Inch)	39	14APR06	07JUN06
QCS Running Tool Procurement & Mfg.	44	16MAY06	17JUL06
QCS Integration & FAT	44	04AUG06	04OCT06
Pipeline 18-Inch to 24-Inch			
Pipeline Repair Tool 18-Inch to 24-Inch	169 *	24APR06	15DEC06



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Data date	30JUN05
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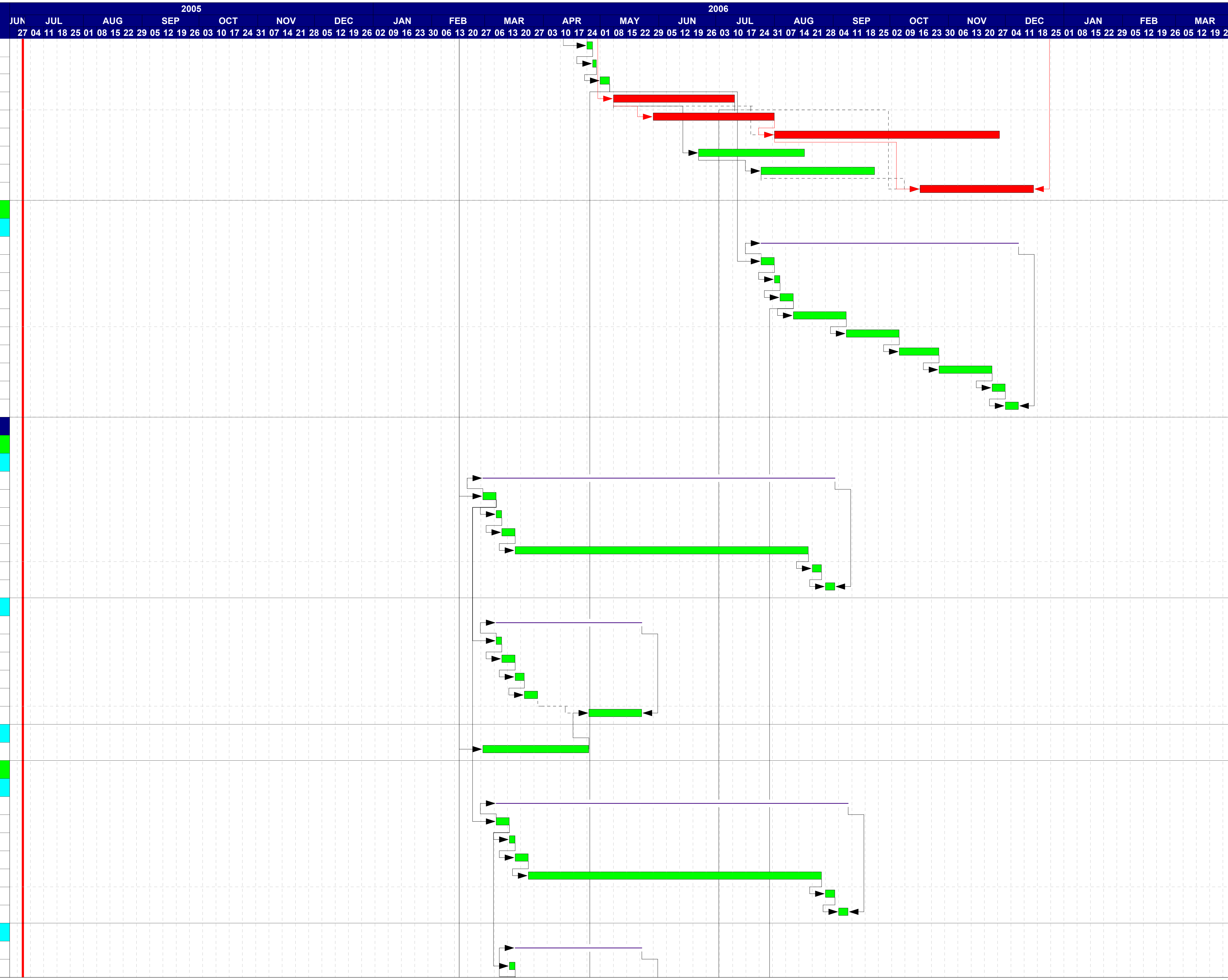
Page number	2A

Stress Subsea, Inc.
DW RUPE Phase 2

Early bar
Progress bar
Critical bar
Summary bar
Start milestone point
Finish milestone point

Description	Orig Dur	Early Start	Early Finish
Update Performance Spec.	3	24APR06	26APR06
Update RFQ	2	27APR06	28APR06
RFQ Response & Issue PO	5	01MAY06	05MAY06
QCS Clamp Engineering	45	08MAY06	10JUL06
QCS Purchase Raw Materials	45	29MAY06	31JUL06
QCS Clamp Procurement & Mfg.	85	01AUG06	27NOV06
QCS Running Tool Engineering (18-Inch)	39	22JUN06	16AUG06
QCS Running Tool Procurement & Mfg.	44	25JUL06	22SEP06
QCS Integration & FAT	44	17OCT06	15DEC06
Non-Size Specific Repair Tools			
Pipeline FBE & Weld Removal (Incl. Running Tool)			
FBE & Weld Removal Tool	98 *	25JUL06	07DEC06
Develop Performance Spec.	5	25JUL06	31JUL06
Issue RFQ	3	01AUG06	03AUG06
RFQ Response & Issue PO	5	04AUG06	10AUG06
Vendor Preliminary Engineering	20	11AUG06	07SEP06
Vendor Detail Design	20	08SEP06	05OCT06
Vendor Procurement	15	06OCT06	26OCT06
Vendor Fabrication / Machining	20	27OCT06	23NOV06
Vendor Coating	5	24NOV06	30NOV06
Vendor Integration & FAT	5	01DEC06	07DEC06
Flowline			
Size Specific Repair Tools - 4-Inch to 7-Inch			
Flowline Connector & Hubs			
Flowline Connectors & Hubs - 4-Inch to 7-Inch	133 *	28FEB06	01SEP06
Develop Performance Spec.	5	28FEB06	06MAR06
Issue RFQ	3	07MAR06	09MAR06
RFQ Response & Issue PO	5	10MAR06	16MAR06
Vendor Procurement & Mfg.	110	17MAR06	18AUG06
Vendor Coating	5	21AUG06	25AUG06
Vendor Integration & FAT	5	28AUG06	01SEP06
Flowline Bends			
Flowline Bends - 4-Inch to 7-Inch	55 *	07MAR06	22MAY06
Calculate Pipe Bend Wall Thickness Reqmts.	3	07MAR06	09MAR06
Develop Flowline Bend Spec.	5	10MAR06	16MAR06
Issue RFQ	3	17MAR06	21MAR06
RFQ Response & Issue PO	5	22MAR06	28MAR06
Vendor Mfg.	20	25APR06	22MAY06
Flowline Misc. Piping			
Receive Participant Free Issue Pipe	40	28FEB06	24APR06
Size Specific Repair Tools - 8-Inch to 10-Inch			
Flowline Connector & Hubs			
Flowline Connectors & Hubs - 8-Inch to 10-Inch	133 *	07MAR06	08SEP06
Develop Performance Spec.	5	07MAR06	13MAR06
Issue RFQ	3	14MAR06	16MAR06
RFQ Response & Issue PO	5	17MAR06	23MAR06
Vendor Procurement & Mfg.	110	24MAR06	25AUG06
Vendor Coating	5	28AUG06	01SEP06
Vendor Integration & FAT	5	04SEP06	08SEP06
Flowline Bends			
Flowline Bends - 8-Inch to 10-Inch	47 *	17MAR06	22MAY06
Calculate Pipe Bend Wall Thickness Reqmts.	3	14MAR06	16MAR06



Start date	30JUN05
Finish date	15DEC06
Data date	30JUN05
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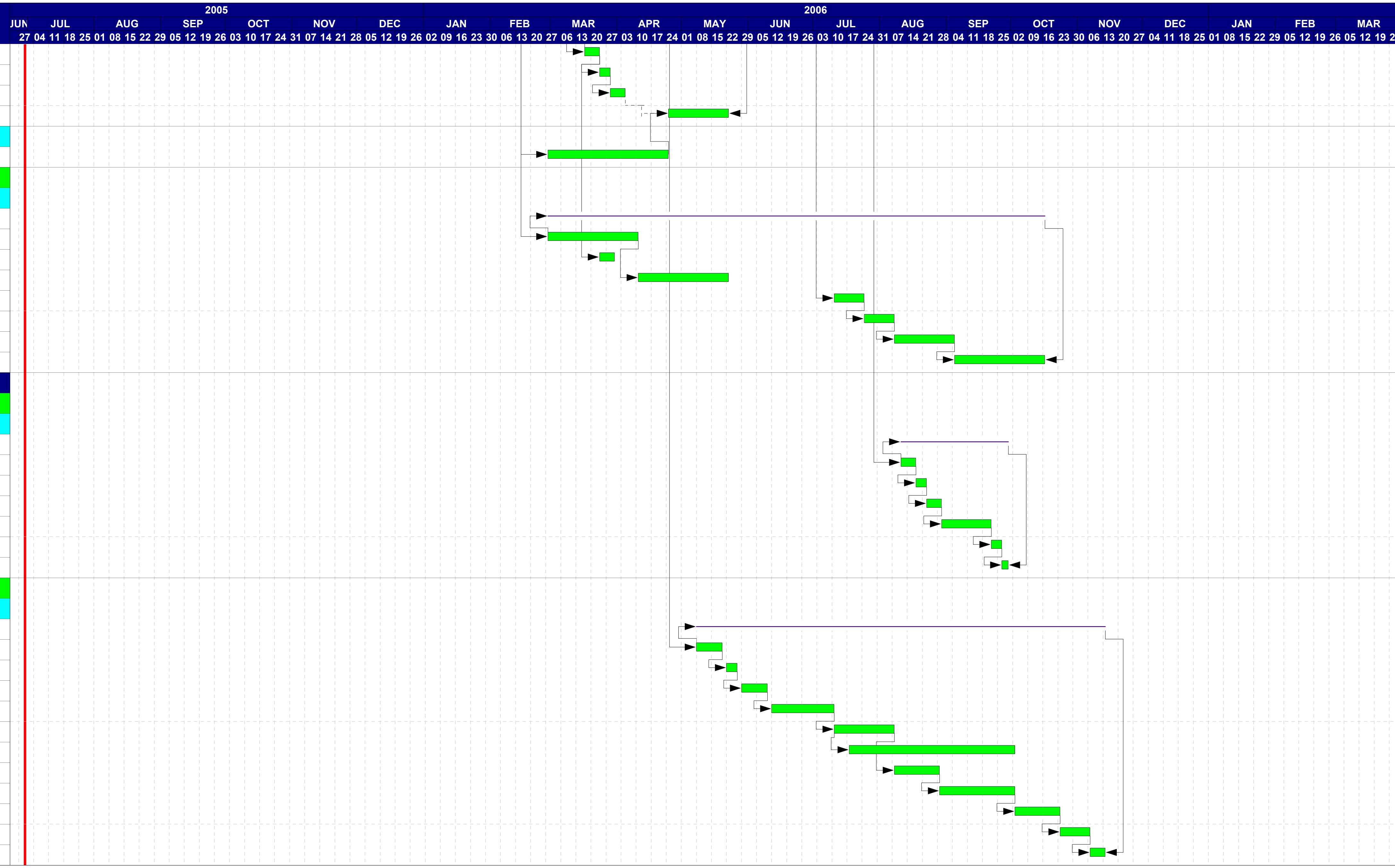
Stress Subsea, Inc.
DW RUPE Phase 2

Early bar
Progress bar
Critical bar
Summary bar
Start milestone point
Finish milestone point

Description	Orig Dur	Early Start	Early Finish
Develop Flowline Bend Spec.	5	17MAR06	23MAR06
Issue RFQ	3	24MAR06	28MAR06
RFQ Response & Issue PO	5	29MAR06	04APR06
Vendor Mfg.	20	25APR06	22MAY06
Flowline Misc. Piping			
Receive Participant Free Issue Pipe	40	28FEB06	24APR06
Non-Size Specific Repair Equipment			
Non-Size Specific Repair Equipment	164 *	28FEB06	16OCT06
Develop Flowline Repair Procedure	30	28FEB06	10APR06
Develop Spec. for Storage of FL Pipe & Bends	5	24MAR06	30MAR06
Develop Spec. for Flowline Repair	30	11APR06	22MAY06
Develop PLET Design Spec.	10	11JUL06	24JUL06
Issue RFQ	10	25JUL06	07AUG06
RFQ Response & Issue PO	20	08AUG06	04SEP06
Vendor PLET Detail Engineering Design	30	05SEP06	16OCT06
Common Tools			
Cutting Tool			
Cutting Tool Development	36 *	11AUG06	29SEP06
Develop Performance Spec.	5	11AUG06	17AUG06
Issue RFQ	3	18AUG06	22AUG06
RFQ Response & Issue PO	5	23AUG06	29AUG06
Vendor Fabrication & Assembly	17	30AUG06	21SEP06
Vendor Coating	3	22SEP06	26SEP06
Vendor Integration & FAT	3	27SEP06	29SEP06
Pipe Lift Frames			
Pipe Lift Frames	135 *	08MAY06	13NOV06
Develop Performance Spec.	10	08MAY06	19MAY06
Issue RFQ	5	22MAY06	26MAY06
RFQ Response & Issue PO	10	29MAY06	09JUN06
Vendor Preliminary Engineering	20	12JUN06	10JUL06
Vendor Detail Design	20	11JUL06	07AUG06
Vendor Long Lead Items	55	18JUL06	02OCT06
Vendor Procurement	15	08AUG06	28AUG06
Vendor Fabrication / Machining	25	29AUG06	02OCT06
Vendor Assembly	15	03OCT06	23OCT06
Vendor Coating	10	24OCT06	06NOV06
Vendor Integration & FAT	5	07NOV06	13NOV06



Start date	30JUN05
Finish date	15DEC06
Data date	30JUN05
Run date	07JUL05
Page number	4A

Stress Subsea, Inc.
DW RUPE Phase 2

Early bar
Progress bar
Critical bar
Summary bar
Start milestone point
Finish milestone point

18.0 APPENDIX 7 – OIL SPILL MITIGATION MEASURES

<u>OIL SPILL MITIGATION MEASURES</u>

By: Ray R. Ayers, PhD, P.E.

October 26, 2005

<u>Introduction</u>

The current oil spill mitigation practice used by deepwater pipeline repair systems designed for the Gulf of Mexico was first developed by Shell for their their deepwater repair system. The Shell system includes a subsea oil collection tent to, in effect, put an “inverted funnel” over the leaking pipe. The lighter oil is separated by gravity in the tent, and the oil/water is then pumped into one of several subsea bladders (bags). The bags are carefully lifted to the surface where the contained oil and water is pumped into more permanent storage. Meanwhile, another bag is being filled subsea, and the process continues until leakage is significantly reduced if not stopped.

There are potential problems with this system and process:

- The apparatus is difficult and delicate to set up subsea.
- It is difficult to perform repair pipe work with ROV and equipment under and around the tent and supports without potentially fouling the tent canopy and supports.
- Filling bladder is a “batch” process, and leakage from the canopy due to being too full, as well as leakage from the valving during bag changing, are potential problems.
- Recovering the bags to the surface and transferring the oil/water mixture to tanks is operationally difficult, and thus a potential problem.
- Normally 10 times more water by volume will be collected than oil, so it is easy to exceed your tank capacity.

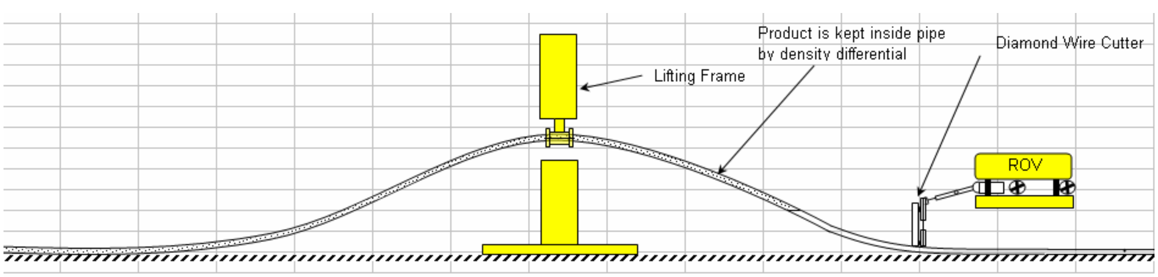
In short, the probability of leakage from these difficult subsea operations, while also trying to make a competent pipeline repair is high, in our opinion.

If the Shell approach is considered "current practice", needed is an improved practice that will be easier and more reliable to implement and operate during an emergency repair.

DW RUPE Proposed Oil Spill Mitigation Method

First, we must recognize that, unfortunately, some oil will be spilled from a leaking pipe before repair and spill mitigation equipment can be mobilized to the repair site and implemented (this takes perhaps 2 to 3 weeks). We assume that both ends of the pipeline or flowline is shut in by appropriate valves so that the pipeline or flowline is not purposefully flowing oil. Thus the only continuing oil release, if any, when equipment arrives at the scene will be that driven by gravity flow based on the density difference.

For DW RUPE we propose to lower twin "A Frames" to the leak location. The first A Frame will be installed well back from the leak area a distance calculated to be a lift point where a "hump will be created as shown here:



This creates a high point of the pipeline segment that is higher than the leak point by several pipe diameters in vertical distance. As a result, as long as the leak point is below the bottom of the pipe at the hump point, leakage cannot occur from gravity flow from the lifted side. In a similar fashion, the second A Frame is placed on the other side, creating a second hump. The pipe damage point is thus located in the “valley” between humps.

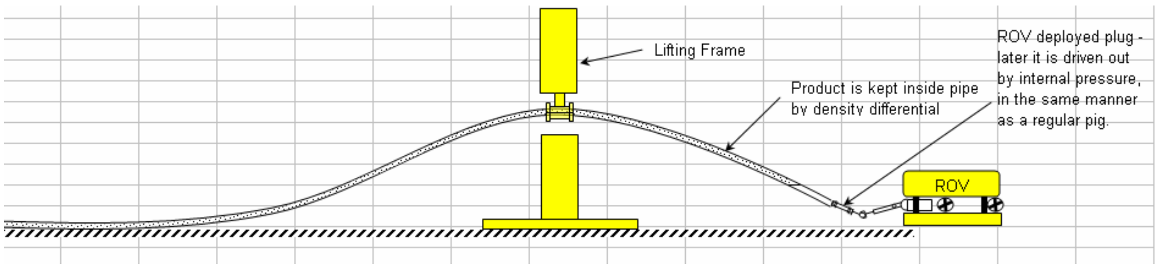
The next step in the oil containment process is to either place a structural leak clamp in place, if there is a pinhole leak, or to cut out a section of damaged pipe if the damage is more severe.

If cuts must be made, the A Frames must be sufficiently away from the cut location such that any springback that occurs, creating a gap, will not cause the pipe ends to slant upward, potentially losing oil by gravity flow. A carefully constructed computer algorithm, based on finite element methodology, is a key to achieving downward sloping pipe ends after the pipe cuts.
Considering springback more fully, deep water routes have very large radius curves, hence the presence of residual bending moment in the vertical plane will necessarily be mild. In that case, for design, the maximum allowable strain (reference API RP 1111) is 0.15%, so any residual spring back is negligible. Thus for the 100 feet of pipe adjacent the cut, we would expect the springback to be less than a few inches per side.

Another potential problem is the pipe "binding" the diamond wire during the cutting process, potentially hanging up the circular blade. Per our meeting with Mike Hargrave from Cutting Underwater Technologies (CUT), CUT has not experienced a problem with wire binding due to residual compression. The circular cross section of the wire tends to bore a hole which relieves any lateral compression in the process.

Even if there were a binding problem, there would be a delay in the cutting process, until the diamond wire is replaced. But in that case, the second cut would take advantage of the relief provided by the first cut, and the pipe will eventually be cut.

Once the pipe ends are downward sloping, the ROV can insert low pressure flexible sealing plugs (pigs) capable of maintaining a seal during subsequent pipeline spoolpiece spool placement activities that follow. Once the spoolpiece is locked in place and sealed, the pigs can then be pumped out as flow is re-started. The figure below shows the downward sloping pipe end with the ROV inserting the piggable plug:



If the leaking pipe is a flowline that will be raised to the surface, then a pipe plug will be provided with the lifting tool, so that oil is not lost during the lifting operation.

The above oil containment process will work either for a high pressure flowline as part of a subsea tieback, or for lower pressure export pipelines.

Assessment of DW RUPE Oil Containment Method

We have evaluated the "hump" method vs. the (Shell) containment tent method, and we believe that the hump method is more controllable, stable and reliable. The hump method allows oil containment to be assured before clamp or spoolpiece installation for pipelines takes place, and before the flowline ends are lowered for a flowline repair. The critical requirement to be assured is that springback resulting from the first cut does not cause hump failure. Springback in deep water is typically less than in shallow water; because pipelay angles in deep water are much more vertical (J lay) than in shallow water (S lay). Because of the vertical angle, it is difficult to achieve a high horizontal tension at the seafloor (leading to large springback).