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DAVIT LAUNCHED TEMPSC
PERFORMANCE
PROJECT

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Health and Safety Executive

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Project No. 44121/00

**Davit Launched TEMPSC
Performance Project**


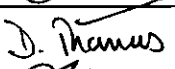
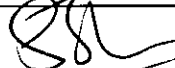
22 April 1997

for

The Health & Safety Executive

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EXECUTIVE SUMMARY

It has been established that there is a lack of performance data and design validation for free-fall and conventional davit-launched Totally Enclosed Motor Propelled Survival Craft TEMPSC. The open literature contains relatively little detailed technical information, and little documentation of existing software and design methods.

The launch of TEMPSC from an offshore installation is a complex sequence of events, involving the condition of the installation itself, the environment, personnel boarding procedures, launch and lowering, impact and entry into the water, release of the craft, and escape from the platform. Extremely complex technical issues are associated with the craft's entry into the water and manoeuvre away from the platform.

There is a need for definitive and systematic model tests and/or full-scale trials to validate theoretical and numerical models, especially models representing TEMPSC entry into the water and its escape from the platform in severe weather conditions. These are needed both to support future design, and to evaluate the operational weather limitations on currently installed systems.

This document describes a proposed davit launched TEMPSC performance project. It is anticipated that the study will be funded by a group of industry and government bodies who have an interest in, and/or responsibility for, the performance of TEMPSC.

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1. INTRODUCTION AND BACKGROUND

It has been established that there is a lack of performance data and design validation for free-fall and conventional davit-launched Totally Enclosed Motor Propelled Survival Craft TEMPSC [1]. Although a literature search has revealed a number of published papers on TEMPSC systems, these contain relatively little detailed technical information, and little documentation of existing software and design methods.

The launch of TEMPSC from an offshore installation is a complex sequence of events, involving the condition of the installation itself, the environment, personnel boarding procedures, launch and lowering, impact and entry into the water, release of the craft, and escape from the platform. Extremely complex technical issues are associated with the craft's entry into the water, including water impact, air entrapment, the possibility of breaking waves, together with structural issues associated with the hull and launch equipment.

There is a need for definitive and systematic model tests and/or full-scale trials to validate theoretical and numerical models, especially models representing TEMPSC entry into the water and its escape from the platform in severe weather conditions. These are needed both to support future design, and to evaluate the operational weather limitations on currently installed systems.

This document describes a proposed davit launched TEMPSC performance and design validation study. It is anticipated that the study will be funded by a group of industry and government bodies who have an interest in, and/or responsibility for, the performance of TEMPSC.

2. OVERALL AIMS, BENEFITS AND OBJECTIVES

2.1. AIM

To undertake work establishing and validating davit launched TEMPSC evacuation performance, particularly in severe weather, thus ensuring optimum operational performance.

2.2. BENEFITS

Duty holders will more effectively be able to fulfil their obligations under the PFEER Regulations, and associated ACOP, by taking into account realistic constraints imposed on TEMPSC in severe weather.

OIMs and Coxswains on installations will have better information for decision making regarding the launch of TEMPSC from specific locations in severe weather.

Duty Holders will have increased confidence, in the demonstration process of Safety Cases, in the design methodologies and analytical tools used, and in their evacuation procedures for severe weather.

2.3. OBJECTIVES

To identify a specific programme of work with associated work scope, obligations, schedules and costings to establish and validate the performance of davit launched TEMPSC evacuation systems, and to identify ways of ensuring best performance of TEMPSC, particularly in severe weather.

To implement the programme, and publish the results. It is anticipated that the programme will contain the following elements:

- a) A scope of work that focuses on effective improvement at a reasonable cost. It is expected that the most common design(s) of offshore davit launched TEMPSC from fixed installations will be studied.
- b) A review of previous work. Although it seems that only a small amount of relevant related work exists, it will be identified and utilised.
- c) A review of the TEMPSC evacuation system functional design methodology and failure modes. There are weather-sensitive features and activities in the TEMPSC launch sequence, and the study will identify them.
- d) The identification of those parameters most critical to the success of TEMPSC evacuation. There will need to be physical testing in order to gain better understanding of severe weather influences on evacuation.
- e) An appraisal of the use of model testing and test facilities. The most cost effective series of model tests will be undertaken.
- f) An agreed series of model TEMPSC tests. It is intended that this should validate current understanding of the TEMPSC descent, release and departure sequence in severe weather conditions.
- g) A full scale TEMPSC test may be performed if it is considered appropriate and practical.
- h) A complete review of the work programme and the results obtained to consolidate and reconcile what has been learnt.
- i) Use of the results to establish practicable weather envelopes for the emergency operation of davit launched TEMPSC from fixed installations in severe weather conditions.

- j) A report to the JIP members, an appropriate version of which will be published in the open literature.

2.4. CONSISTENCY WITH HSE RESEARCH OBJECTIVES

The project is consistent with an HSE OSD research objective of improving the effectiveness of evacuation by TEMPSC. The project is also consistent with an OSD approach to research on evacuation systems which includes the review of systems to determine gaps in understanding, and their significance.

3. PROJECT BOUNDARIES

The following project boundaries are proposed:

- a) TIMEFRAME - From commencement of launch to escape from the vicinity of the platform.
- b) TEMPSC design and launch system selection to be based on the most common designs offshore.¹
- c) Installation type selection will take account of typical risk per evacuation by TEMPSC ² [2]. Expected likelihood of using the TEMPSC will also be taken into account.
- d) Data obtained from the project is to be suitable for open publication.
- e) Selection of parameters to be modelled / validated will depend upon:
 - those parameters critical to the success of TEMPSC evacuation in severe weather,
 - those parameters which have most need for validation, and
 - those parameters which are capable of effective validation by modelling at reasonable cost.
- f) Selection of parameters will be determined and justified by a review of TEMPSC evacuation failure modes and TEMPSC evacuation system design methods.

¹HSE OSD is currently carrying out an in-house review to determine the most common designs, including launch orientation and height above water.

² On this basis, TEMPSC on ship-shaped installations will not be selected since these installations generally have a lower risk per TEMPSC evacuation than for a fixed platform or semi-submersible installation.

4. MAIN PERFORMANCE REQUIREMENTS

The main performance requirements concern the entry of the craft into the water, and the escape from the platform vicinity.

There would seem to be little doubt that compliance with the various regulatory body and classification society regulations ensures that the craft will operate safely in calm weather conditions. There have been many trials and training exercises conducted over the years to ensure that this is the case.

There is, however, very little data to verify the performance of these TEMPSC evacuation systems in moderate or severe weather conditions. It is also not clear to what extent designers take severe weather conditions into account, or consciously set operational weather limits in their designs.

In the performance of risk analyses for fixed platforms it can probably be shown that the requirement for an evacuation is relatively independent of weather, placing less emphasis on an evacuation system which can be guaranteed to work in the most severe sea-states (the risk of evacuation at the same time as a severe storm is small). However, for floating systems (FPSOs and drilling rigs) the risk of evacuation may be more strongly correlated with, or be a direct consequence of, severe weather.

The selection of a rational 'design weather criterion' or operational weather limit for any particular escape system requires consideration of the risks and consequences of the potential emergency situations

The main shortcoming in the current validation of design methods concerns this performance in severe weather and focuses on two key phases of the escape process:

- TEMPSC entry into the water, and
- getting underway and escaping from the vicinity of the platform.

The ways in which severe weather can cause a failure in these phases will be studied by means of a Failure Modes Analysis during the initial stage of the project, but the two phases are discussed in more detail in the following.

4.1. ENTRY INTO THE WATER

The process of entry into the water is different for conventional davit-launched, free-fall, or other novel launch systems (such as PROD, TOES etc.). However, they share some common features and technical issues.

The current project will concentrate on davit-launched TEMPSC because at present they represent the majority of installations on offshore structures in the UK sector of the North Sea.

Prior to impact with the water the TEMPSC may have moved closer to the installation due to the effects of wind on the TEMPSC during descent.

The initial impact with the water occurs when the TEMPSC is still suspended on the wires, and in severe waves will result in slamming, shock loads in wires and attachments, and potentially swinging of the TEMPSC on the wires as a wave front passes. This can in turn lead to higher velocities of impact with the next wave, as well as the risk of swinging back and hitting the platform.

These effects are particularly complex in severe (possibly breaking) multidirectional waves, and lead to a large population of possible water impact conditions, structural loads and

accelerations. The effect of these on the motions and forces experienced by the craft are also very difficult to estimate because both the wave kinematics and the slamming forces are poorly understood.

4.2. ESCAPE FROM THE VICINITY

Once in the water, all types of craft have to avoid collision with the installation. The problem for davit-launched TEMPSC is somewhat more severe than for free-fall or other novel designs where the craft enters the water at a greater distance from the platform.

Once free in the water the craft may expect horizontal wave motions of the same order as the wave height, and even if launched on the lee side of the platform, may be swept back into the platform if it happens to be launched into the rear face of a very large wave crest. In all cases it is essential that the craft gets underway quickly, and is capable of turning and making some headway into the weather.

4.3. FAILURE MODES ANALYSIS

Overall it is clear that severe weather conditions can potentially lead to a number of failures of a davit-launched TEMPSC evacuation system. Some of the more obvious potential failures are:

- Swinging of TEMPSC into platform structure causing consequent damage.
- Heavy impact with an advancing wave causing damage to the TEMPSC or failure of the davits/falls.
- Large drop into wave trough caused by a release a few seconds after a wave crest impact.
- Capsize of TEMPSC caused by large breaking wave.
- Strong winds and waves sweeping TEMPSC back into a collision with the platform during the escape manoeuvre.

These failure modes will be studied in the first phase of the project.

4.4. VALIDATION FOR SEVERE WEATHER

The inherent variability of these effects is a very important issue. Each time a TEMPSC is launched into a severe wave it will meet a different part of a different wave coming from a different direction and with a different surface texture. The swinging of a davit-launched TEMPSC will also be different if launched from a moving platform. Ideally the design process should take account of this variability, and ensure that there is an adequately low probability of failure in any designated operational weather condition.

The variability also means that a small number of validation full scale trials or model tests is alone of very limited benefit. Such trials either have to be performed in great numbers (which is only practical at the model scale) or need to be used to validate a numerical model which can then be used to produce the large population of data required to determine the variability.

4.4.1. Full scale trials

Full scale trials in very severe weather conditions are also very difficult to envisage in practice. Some of the difficulties are:

- Cost.
- Waiting for the required weather conditions.
- Potential loss of the unmanned craft.

- Potential damage to surrounding installations by an out of control unmanned craft.
- Potential risk to life and limb when trying to recover the craft and/or protect installations.
- Difficulty in measuring the weather conditions with sufficient accuracy.
- Even if successful, the deliverable may not represent more than *ONE DATA POINT*. In view of the inherent variability, this could not be used directly to validate design.

Of the above difficulties, probably the last is the most crucial. Whilst it is not ruled out that a full scale trial could be mounted to measure the performance of a TEMPSC in severe weather conditions (perhaps in a coastal location), the cost of the exercise would be likely outweigh any limited benefit that might accrue.

4.4.2. Model tests

The other means of generating validation data is physical model testing. Such tests offer the prospect of launching the TEMPSC many times under controlled conditions, and thus building up a significant database of structural loads, motions and accelerations for a range of sea-states. This data could either be used to validate a numerical model, or it could be used directly in design.

However, model tests of this type also present a number of problems. Some of these are:

- Ensuring a large enough model to permit sufficient instrumentation to be carried (requires a model basin with very large waves).
- Possible scale effects - see below.
- Difficulty in modelling craft structural properties (perhaps required for slamming pressure measurements).
- Large amounts of basin time required to repeat runs many times in a reasonable range of wave conditions and headings.
- Probable requirement to simulate wind as well as waves (wind has a key influence on the TEMPSC whilst lowering on the falls, manoeuvring once in the water, and also may have a significant effect on the wave forces experienced).

4.4.3. Validation of model tests

If, as is suggested above, model tests are the only practical way of investigating TEMPSC performance in severe waves, then there needs to be a phase of work which deals with the potential scale effects noted above, and which validates the model testing approach.

Some degree of validation of model test results can in principle be performed against trials performed in TEMPSC in calm conditions, but unfortunately many aspects of the TEMPSC performance that are of interest in the context of the present project are closely linked with the effects of severe waves, and so this validation can only be limited.

In the case of conventional davit-launched TEMPSC the entry into calm water is relatively slow, and quite unlike the entry into severe waves. Consequently comparison can only usefully be made in the area of calm water manoeuvring performance. This is nevertheless a key factor in the ability of all types of TEMPSC to escape from the platform vicinity, and a correlation with trials data will permit the models ability to accelerate and perform a turn to be calibrated against the full scale. Model tests have certain Reynolds number scale effects which are known to influence manoeuvring performance. These are mostly due to the greater resistance of the model, the need to provide extra thrust to balance this additional resistance, and the tendency of this additional thrust to give the model more ability to

accelerate and turn than it should have. The results of a calm water manoeuvring trial can therefore be used to adjust the model thrust and model turning performance.

Any attempt to validate seakeeping performance or hull slam effects would require a trial to be performed lowering the TEMPSC into severe conditions, and the comments in Section 4.4.1 apply. Whilst a comprehensive research study into impacts of structures with the surface of the sea would benefit a number of marine technology areas, it is considered to be beyond the scope of this particular study.

The following sections contain an outline specification for a series of model tests to provide some validation of the model testing approach, and data on the water entry and escape from the vicinity in severe weather conditions. It may optionally include the validation of simulation software.

5. VALIDATION SPECIFICATION

5.1. OBJECTIVES

To obtain data on davit-launched TEMPSC water entry and escape from platform vicinity performance which can be used to compare with the results of TEMPSC evacuation system design methods, and to contribute to establishing the operational weather limits for TEMPSC evacuation systems on existing installations. The particular parameters to be measured will be determined as outlined in Section 3, but indicative parameters to be measured are given below.

More specifically, these objectives can be defined as follows:

- a) To obtain, by means of model tests, data on the water entry motions and accelerations of a TEMPSC in severe weather conditions which can be compared directly with the results of TEMPSC evacuation system design methods.
- b) To obtain data on the TEMPSC manoeuvrability and ability to escape from the vicinity of the launch platform in severe weather conditions.
- c) To obtain sufficient data in (a) and (b) above to permit *both* deterministic comparison with simulations software runs, *and* to estimate the statistical variability of the various TEMPSC responses.
- d) To make detailed comparisons of the results of the model tests with the results from TEMPSC launch simulation program(s), and draw conclusions on the validity of the simulations. (OPTIONAL)
- e) To validate the model testing approach as far as possible by comparison with data from TEMPSC trials in calm water, or by other appropriate means.
- f) To publish the results of the above as a series of reports in the open literature so that the data and validation may be freely used by the industry to support analysis and TEMPSC system design.

5.2. FAILURE MODES ANALYSIS

In order to focus the activities in the main part of the project, the initial phase will be a desk study of the various failures that may be initiated in the TEMPSC evacuation system by severe weather conditions.

The study will start with a literature search and will review information revealed by this search and the results of previous research work in the field commissioned by HSE. Failure modes which are independent of weather conditions will be ignored.

When these weather-induced failure modes have been identified, the remainder of the project will be reviewed in the light of these modes, to ensure that they will be adequately covered by the program of model tests and trials envisaged.

5.3. MODEL DESIGN AND SCALE

1. Model:

- 1.1. TEMPSC - design(s) to be determined.
- 1.2. Launch system to include a launch mechanism which can be automatically triggered at a predetermined time or at a predetermined wave phase angle.
- 1.3. For manoeuvring tests - TEMPSC propulsion and steering. (Might be fixed to perform a simple turn into weather, or optionally controlled from shore by radio control.)

- 1.4. Representation of platform legs, mainly for visual/spatial reference. (Installation type to be determined, but expected to be a fixed platform.)
2. **Model scale** - To be selected according to basin, but leading to a model size sufficiently large to permit the instrumentation requirements below.

5.4. OUTLINE MODEL TEST VALIDATION SPECIFICATION

As indicated in Section 4.4.3, comparison of model test with TEMPSC full scale trials performed in calm water can provide a degree of confidence in the model tests performed later in severe wave conditions.

A key aspect of performance for all types of TEMPSC is their ability to manoeuvre away from the platform vicinity, and the model test validation here seeks to ensure that the model performance correctly represents full scale performance.

On full scale:

- Perform manoeuvring trials in calm water and in the absence of wind. Tests to include accelerate and make 90° turn from stationary (the common escape manoeuvre). Also perform conventional manoeuvring tests such as turning circle.³

On the model:

- Repeat tests for the model. Make adjustments to thruster power and rudder size/angle to ensure model performance is similar to full scale.

5.5. SEVERE WAVES MODEL TEST OUTLINE SPECIFICATION

The main part of the model testing program, performed in severe weather conditions is specified in the following:

1. **Wave conditions** - to be determined⁴.
2. **Wind speed** - to be determined.
3. **Wave Spectra** - to be determined
4. **Instrumentation: (Indicative only)**
 - 4.1. Wave elevation.
 - 4.2. Wind speed.
 - 4.3. TEMPSC trajectory (in air) (by optical tracking technique?).
 - 4.4. TEMPSC linear accelerations at CG in 3 axes.
 - 4.5. TEMPSC roll and pitch velocity (rate gyros). Optionally add yaw.
 - 4.6. TEMPSC hull slamming pressures (optional).
 - 4.7. Video record of all tests.

5.5.1. Test Program - Part I - Water Entry

1. **Irregular Waves**
 - 1.1. In 2 random sea-state / wind combinations, and 3 headings to the weather, launch the TEMPSC 20 times at random times in the irregular wave sequence.
 - 1.2. Data analysis: Statistical analysis of maximum values of all parameters experienced in each of the 20 runs. Derive maximum, minimum and standard deviation (in order to quantify the variability between different

³ This information may be available in the literature, and may therefore not require trials measurement.

⁴ The storm conditions selected for the tests are to be chosen to be typical of those required. Typical 'limiting weather conditions' for TEMPSC systems quoted in safety cases can perhaps be provided by HSE.

launches). Present time series results for examination in hard copy and electronic form.

2. Regular Waves

- 2.1. Additional testing as required if optional validation against computer simulation software is required.

5.5.2. Test Program - Part II - Escape from Vicinity

1. Irregular Waves

- 1.1. In 2 random sea-state / wind combinations, and 3 headings to the weather, launch the TEMPSC 20 times at random times in the irregular wave sequence.
- 1.2. Data analysis: None. Video record, and note success or otherwise of the escape manoeuvre⁵.

2. Regular Waves

- 2.1. Additional testing as required if optional validation against computer simulation software is required.

5.6. SOFTWARE VALIDATION OUTLINE SPECIFICATION

The specification of validation software simulation runs can only be in outline when the software to be validated is selected, and the simulation data deliverables studied in detail.

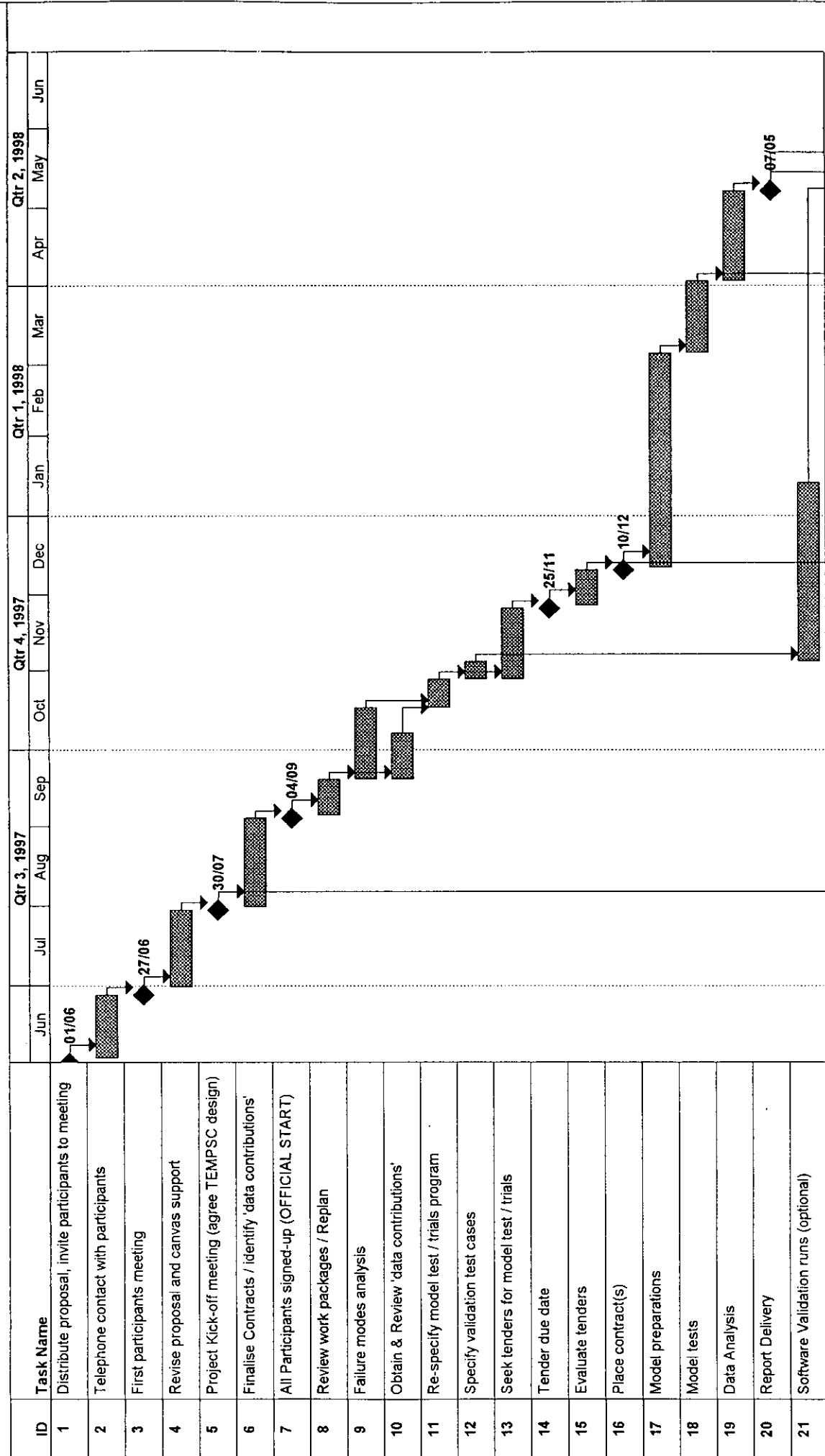
⁵ The success of the escape manoeuvre needs to be defined.

6. JIP PROJECT ELEMENTS

The following summarises the main steps in the planning and execution of the validation study:

1. Identify Joint Industry Project Participants. Some will fund the work with cash contributions (e.g. Oil Companies, HSE). Others may provide work/assistance 'in-kind' (e.g. TEMPSC designers, manufacturers, software companies).
2. If required, revise / amend the scope of work to fit the particular interests of the participants.
3. Agree the TEMPSC design (or designs) and launch method (or methods) to be studied.
4. Prepare detailed specifications of each of the work packages which form the research project.
5. Assign the work packages to the 'in-kind' participants and seek commercial bids for elements which cannot be dealt with in this way (eg. model testing).
6. Let commercial contracts and set 'in-kind' tasks in progress.
7. Perform software runs. Take delivery of validation run reports and data
8. Perform model test program. Take delivery of model test report and data.
9. Comparison of model test results with current design techniques
 - 9.1. Comparison with TEMPSC system design methods
 - 9.2. Comparison of results with software simulations
10. Preparation of Reports (confidential to JIP members):
 - 10.1. Critique of TEMPSC system design methods
 - 10.2. Validation(s) of Computer Software
11. Preparation of Open Publications
 - 11.1. (topics broadly as above, but cut-down versions)

In the following pages a preliminary plan of the project is presented. This indicates a total duration of approximately 12 months. The plan presumes that certain pre-project activities have been completed beforehand. These will include; identifying all the likely participants, identifying existing commercially held data which may fulfil some part of the project objectives etc.



Project: TEMPSC Validation
Date: Thu 24/04/97

Task: [Hatched Bar]

Progress: [Solid Bar]

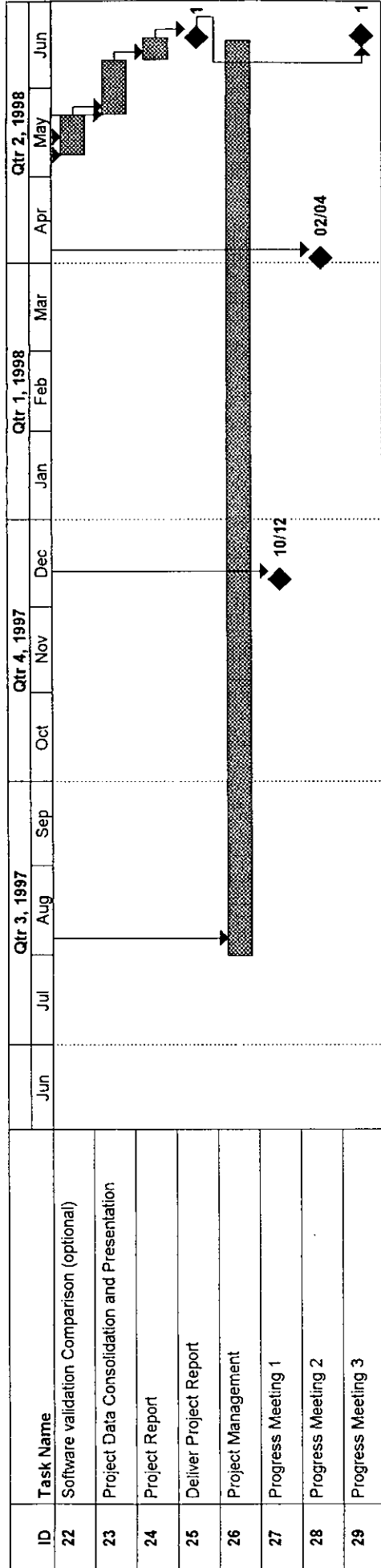
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Summary: [Hatched Bar]

Rolled Up Task: [Hatched Bar]

Rolled Up Milestone: [Diamond]

Rolled Up Progress: [Hatched Bar]



Project: TEMPSC Validation
 Date: Thu 24/04/97

7. PROJECT BUDGET COSTS

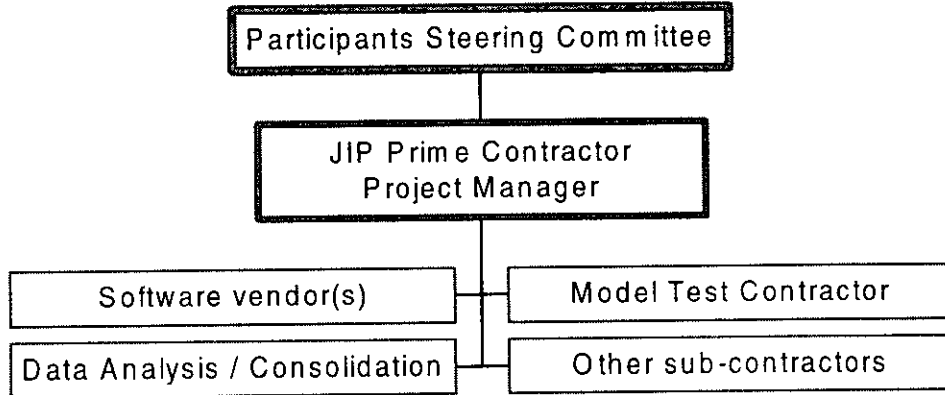
At this stage detailed costs have not been estimated. However, initial indications are that the project will cost approximately £250k to complete.

This cost might be shared equally by 5 participants at £50k each, or by 7 participants at £35k each. If the participants were of several different types (e.g. some oil companies, some TEMPSC designers, some software vendors) then it may be more appropriate for there to be different levels of participation fee for different organisation types. Some participants may cover all or part of their fee by providing data or work as an 'in-kind' contribution. Detailed proposals will have to be developed on the fee structure when the pattern of likely participation becomes clearer.

8. PROJECT ORGANISATION

It is anticipated that the project will be organised broadly as follows:

TEMPSC Performance - Joint Industry Project



The JIP prime contractor will perform all project management and co-ordination activities and will supply the project manager. Ideally, the prime contractor will also have the necessary technical skills to perform the data analysis and validation roles. He will also prepare and present the final report. Key subcontractors will prepare and submit reports on their own parts of the work.

9. REFERENCES

[1] *Review of Tools and Data for the Assessment of Launch of Free-Fall and Conventional TEMPSC*, HSE Report OTN 95 135.

[2] *Risk Assessment of Emergency Evacuation from Offshore Installations*. Technica September 1983, HSE Report OTO 83 050.