Dependency can be viewed as a particular type of PSF. The levels of a pre-defined set of PSFs are set in PHRASE 2. See Figure 5 below.

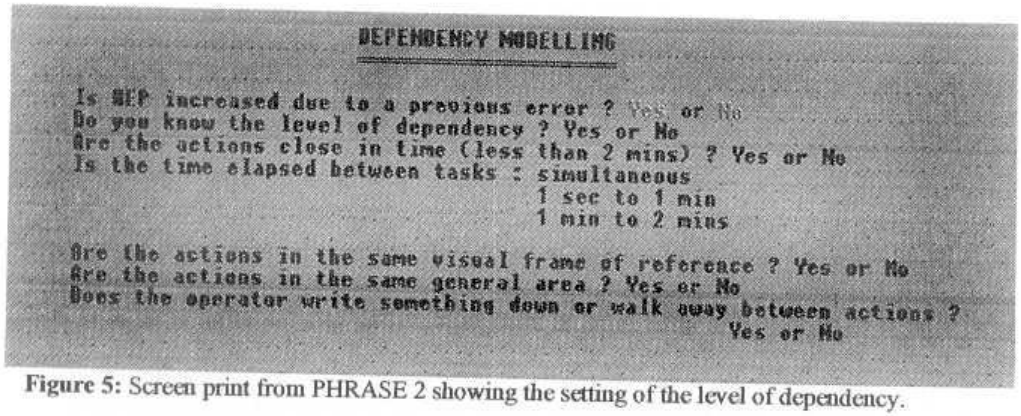

Figure 5: Screen print from PHRASE 2 showing the setting of the level of dependency.

iv. Quantify HEP.
Information about error type and PSFs are then combined to generate an HEP. In PHRASE 2, a basic HEP is extracted from a database for the type of human error defined. This value is then modified according to the prevailing PSFs.

PHRASE 2 classifies all tasks as either pre-diagnostic, diagnostic or post diagnostic. A 'Pre-diagnosis Task' could be either a) a task performed early in the flight or more likely, b) a task performed by ground crew maintenance which leaves the in-flight systems not in their expected state of readiness. A diagnostic task would be diagnosing a system failure in the aircraft or the cognitive performance of a mission oriented task such as identifying a target. PHRASE 2 uses the Human Cognitive Reliability Model here, which assumes that performance on a Diagnosis Task can be predicted from the time available for the task. The 'Post Diagnosis Task' is modelled in the same way as the 'Pre-Incident Task' as described in i-iv above.

v. Evaluate impact of error on system (consider immediate effect of error, knock-on effects of error and recovery from error).
PHRASE 2 allows the calculation of error probabilities for actions required to recover from an error. This can include a diagnostic or a post diagnostic task. However, in order to determine the implications for mission success, either an event tree or a fault tree is commonly used. Event trees start from the basic initiating event and map out the major event sequences leading either to recovery of normal status or to accident conditions. Fault trees tend to look at the combinations of system and operator failures that contribute to the mission failure.

vi. Error reduction (consider error mechanisms and PSFs)
High risk errors can be addressed by redesign. Information on the psychological mechanism behind an error and the sensitivity of the HEP to PSFs levels provide guidance for redesign. PHRASE 2 does not provide information on the psychological mechanisms behind an error, but other HRA tools do (*e.g.*, SHERPA[1]). Other HRA tools also link errors and PSFs to Error Reducing Mechanisms - ERMs (*e.g.*, HEART).

4. Limitations

i. PHRASE 2 and THERP[1] (on which PHRASE 2 is based) have been developed primarily for addressing human error in process control. As such, the use of this specific tool is limited for cockpit design.
ii. The level of system specification must be sufficient to support a detailed task analysis.

It is important to understand that a full HRA requires a detailed task analysis to be in place.

5. Facilities/Resource Requirements

PHRASE 2 runs on a PC and is produced and distributed by Electrowatt Engineering Ltd:

Electrowatt Engineering Ltd.
North Street
Horsham
West Sussex
RH12 1RF
UK
Tel. 44 (0)1403 250131

HEART is an alternative to THERP and is an example of a HRA technique that has been developed to be quick, simple to use and easily